```
In [64]: import numpy as np
         import matplotlib.pyplot as plt
         import pandas as pd
         import os
         from sklearn.preprocessing import MinMaxScaler
         from keras.models import load_model, Model
         from keras.layers import LSTM, Dense, Input
         from keras.optimizers import Adam
         import keras.backend as K

In [65]: def get_csvs_from_dir(directory):
             try:
                 datasets_dir = os.path.join(directory, 'environment', 'datasets')
                 csv_files = [os.path.join(datasets_dir, file) for file in os.listdir(datasets_di
                 stock_names = [file.split("\\")[-1].split(".")[0] for file in csv_files]
                 return csv_files, stock_names
             except FileNotFoundError:
                 print(f"The directory {datasets_dir} does not exist.")
                 return [], []

         def load_data(file_path):
             df = pd.read_csv(file_path)
             df['datetime'] = pd.to_datetime(df['date'])
             df.set_index('datetime', inplace=True)
             df = df['close'].resample('D').mean()
             df.interpolate(method='linear', inplace=True)
             return df

         def build_model(input_shape):
             K.clear_session()
             input_layer = Input(shape=(input_shape[1], input_shape[2]))
             lstm_layer = LSTM(50, activation='relu')(input_layer)
             output_layer = Dense(1)(lstm_layer)
             model = Model(inputs=input_layer, outputs=output_layer)
             model.compile(optimizer=Adam(), loss='mse')
             return model

         def process_stock_data(data, start_date, end_date):
             data_filtered = data[start_date:end_date]
             sc = MinMaxScaler(feature_range=(0, 1))
             data_scaled = sc.fit_transform(data_filtered.values.reshape(-1, 1))
             X, y = [], []
             for i in range(10, len(data_scaled)):  # Window size is 10
                 X.append(data_scaled[i-10:i, 0])
                 y.append(data_scaled[i, 0])
             X, y = np.array(X), np.array(y)
             X = X.reshape(X.shape[0], X.shape[1], 1)
             return X, y, sc, data_filtered.index[10:]  # Adjust index to match data

         def plot_results(data, test_dates, predictions):
             # Ensure test_dates is a DatetimeIndex and aligns with the data DataFrame
             test_dates = pd.to_datetime(test_dates)  # Ensure it's in datetime format if not alr

             plt.figure(figsize=(14, 7))
             # Plotting the actual close prices for the test dates
             plt.plot(test_dates, data[test_dates], label='Actual')
             # Plotting the predictions; ensuring test_dates is correctly used as the x-axis
             plt.plot(test_dates, predictions, color='red', linestyle='--', label='LSTM Forecast'
             plt.title('LSTM Rolling Forecast')
             plt.xlabel('Date')
             plt.ylabel('Daily Close Price')
             plt.legend()
             plt.grid(True)
```

```python
        plt.show()

def train_and_forecast(file_path, model_dir):
    data = load_data(file_path)
    train_start, train_end = '2002-01-01', '2015-12-31'
    test_start, test_end = '2016-01-01', '2018-12-31'

    X_train, y_train, sc_train, _ = process_stock_data(data, train_start, train_end)
    X_test, y_test, sc_test, test_dates = process_stock_data(data, test_start, test_end)

    #! FULL TEST_DATES (including the first 10 days)
    test_dates = data[test_start:test_end].index

    model_path = os.path.join(model_dir, 'lstm_model.h5')
    if os.path.exists(model_path):
        model = load_model(model_path)
        print("Model loaded.")
    else:
        model = build_model(X_train.shape)
        model.fit(X_train, y_train, epochs=20, batch_size=32, validation_split=0.1, verb
        model.save(model_path)
        print("Model trained and saved.")

    predictions = model.predict(X_test).flatten()
    predictions = sc_test.inverse_transform(predictions.reshape(-1, 1)).flatten()

    # Prepend the first 10 days of real close values from the test set to the prediction
    first_10_days = data[test_start:test_end].head(10).values
    predictions = np.concatenate([first_10_days, predictions])

    results_path = os.path.join(model_dir, 'predictions.csv')

    if os.path.exists(results_path):
        results_df = pd.read_csv(results_path)
        results_df['lstm'] = pd.Series(predictions)
        results_df.to_csv(results_path, index=False)
    else:
        os.makedirs(os.path.dirname(results_path), exist_ok=True)
        results_df = pd.DataFrame({'date': test_dates, 'lstm': predictions})
        results_df.to_csv(results_path, index=False)
    print(f"Predictions saved to {results_path}.")

    # Plotting
    plot_results(data, test_dates, predictions)
```

```python
def process_stocks(project_dir):
    datasets, stock_names = get_csvs_from_dir(project_dir)
    for file_path, stock_name in zip(datasets, stock_names):
        print(f"Processing {stock_name}...")
        results_dir = os.path.join(project_dir, 'agents', 'trained_models', stock_name)
        if not os.path.exists(results_dir):
            os.makedirs(results_dir)
        train_and_forecast(file_path, results_dir)

if __name__ == '__main__':
    project_dir = os.path.dirname(os.path.dirname(os.getcwd()))
    process_stocks(project_dir)
```

```
Processing a...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0229 - val_loss: 6.9125
e-04
Epoch 2/20
144/144 [==============================] - 0s 3ms/step - loss: 3.3877e-04 - val_loss: 4.
8679e-04
```

```
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 3.0931e-04 - val_loss: 3.
9827e-04
Epoch 4/20
144/144 [==============================] - 0s 3ms/step - loss: 2.9008e-04 - val_loss: 3.
6420e-04
Epoch 5/20
144/144 [==============================] - 0s 3ms/step - loss: 2.8124e-04 - val_loss: 3.
2699e-04
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 2.7533e-04 - val_loss: 2.
9913e-04
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 2.5628e-04 - val_loss: 3.
1809e-04
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 2.4405e-04 - val_loss: 3.
1228e-04
Epoch 9/20
144/144 [==============================] - 0s 2ms/step - loss: 2.3440e-04 - val_loss: 2.
5944e-04
Epoch 10/20
144/144 [==============================] - 0s 2ms/step - loss: 2.2480e-04 - val_loss: 2.
3200e-04
Epoch 11/20
144/144 [==============================] - 0s 2ms/step - loss: 2.0780e-04 - val_loss: 2.
7833e-04
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 2.0269e-04 - val_loss: 2.
0998e-04
Epoch 13/20
144/144 [==============================] - 0s 2ms/step - loss: 1.9685e-04 - val_loss: 1.
9557e-04
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8665e-04 - val_loss: 1.
9108e-04
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8289e-04 - val_loss: 1.
8588e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8080e-04 - val_loss: 1.
7948e-04
Epoch 17/20
144/144 [==============================] - 0s 3ms/step - loss: 1.7509e-04 - val_loss: 2.
3164e-04
Epoch 18/20
144/144 [==============================] - 0s 3ms/step - loss: 1.7089e-04 - val_loss: 1.
6790e-04
Epoch 19/20
144/144 [==============================] - 0s 2ms/step - loss: 1.7581e-04 - val_loss: 1.
8199e-04
Epoch 20/20
144/144 [==============================] - 0s 2ms/step - loss: 1.7476e-04 - val_loss: 2.
4123e-04
Model trained and saved.
d:\ProgramFiles_Storage\anaconda3\Lib\site-packages\keras\src\engine\training.py:3103: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. This file form
at is considered legacy. We recommend using instead the native Keras format, e.g. `mode
l.save('my_model.keras')`.
  saving_api.save_model(
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\a\predictions.csv.
```

LSTM Rolling Forecast

```
Processing aapl...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0178 - val_loss: 6.9820
e-04
Epoch 2/20
144/144 [==============================] - 0s 3ms/step - loss: 5.5900e-05 - val_loss: 4.
6848e-04
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 5.7718e-05 - val_loss: 4.
2728e-04
Epoch 4/20
144/144 [==============================] - 0s 2ms/step - loss: 5.4602e-05 - val_loss: 4.
3130e-04
Epoch 5/20
144/144 [==============================] - 0s 2ms/step - loss: 5.4951e-05 - val_loss: 3.
6356e-04
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 5.2050e-05 - val_loss: 3.
0811e-04
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 5.3394e-05 - val_loss: 5.
7001e-04
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 5.2853e-05 - val_loss: 3.
6194e-04
Epoch 9/20
144/144 [==============================] - 0s 2ms/step - loss: 5.1651e-05 - val_loss: 3.
3762e-04
Epoch 10/20
144/144 [==============================] - 0s 3ms/step - loss: 5.1007e-05 - val_loss: 6.
2809e-04
Epoch 11/20
144/144 [==============================] - 0s 3ms/step - loss: 5.1282e-05 - val_loss: 3.
5434e-04
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 4.8284e-05 - val_loss: 6.
1259e-04
Epoch 13/20
144/144 [==============================] - 0s 2ms/step - loss: 4.8757e-05 - val_loss: 3.
7236e-04
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 4.7564e-05 - val_loss: 4.
```

```
6458e-04
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 4.6781e-05 - val_loss: 5.
7525e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 4.6262e-05 - val_loss: 4.
6460e-04
Epoch 17/20
144/144 [==============================] - 0s 2ms/step - loss: 4.3467e-05 - val_loss: 4.
0547e-04
Epoch 18/20
144/144 [==============================] - 0s 2ms/step - loss: 4.5480e-05 - val_loss: 7.
1184e-04
Epoch 19/20
144/144 [==============================] - 0s 3ms/step - loss: 4.6896e-05 - val_loss: 2.
5340e-04
Epoch 20/20
144/144 [==============================] - 0s 3ms/step - loss: 4.3491e-05 - val_loss: 5.
2076e-04
Model trained and saved.
```
```
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\aapl\predictions.csv.
```


LSTM Rolling Forecast
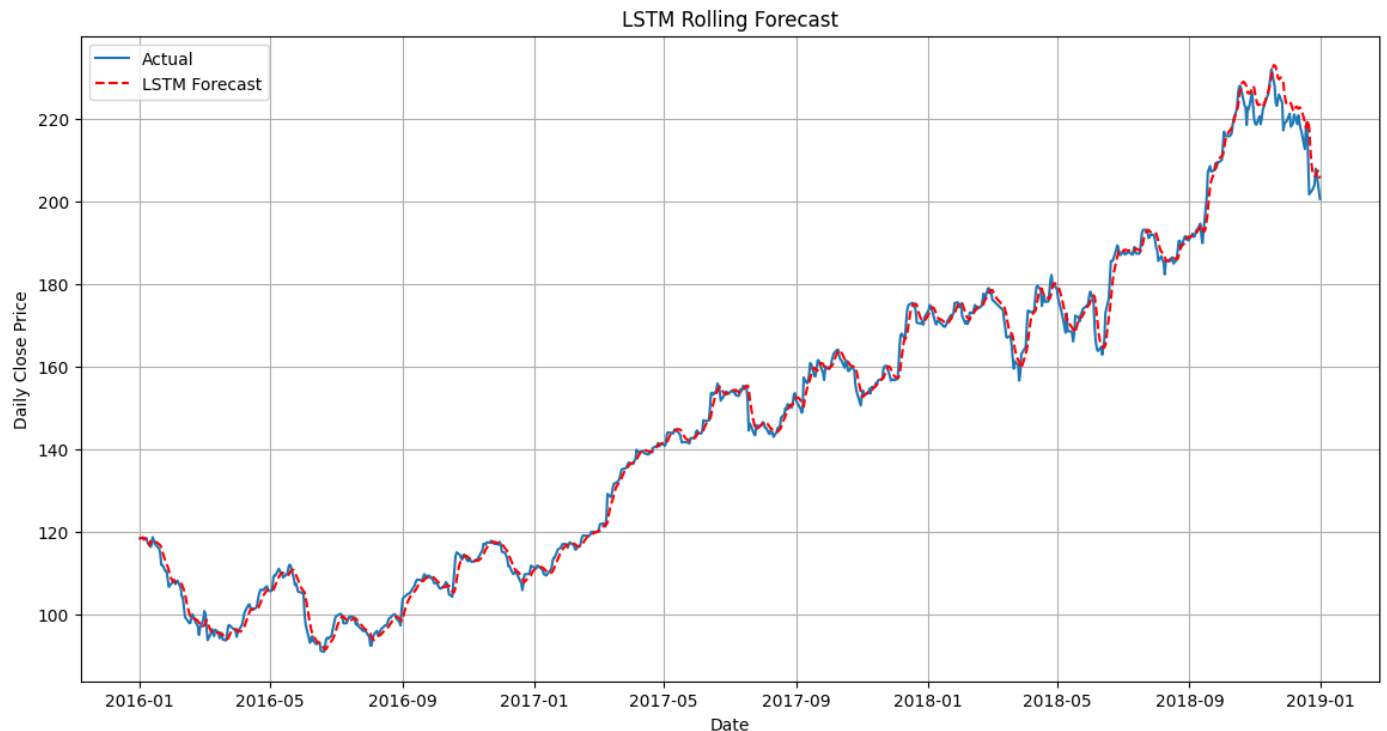
```
Processing abc...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0076 - val_loss: 0.0049
Epoch 2/20
144/144 [==============================] - 0s 2ms/step - loss: 3.2292e-05 - val_loss: 0.
0051
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 3.3301e-05 - val_loss: 0.
0040
Epoch 4/20
144/144 [==============================] - 0s 2ms/step - loss: 3.1937e-05 - val_loss: 0.
0040
Epoch 5/20
144/144 [==============================] - 0s 3ms/step - loss: 3.2118e-05 - val_loss: 0.
```

```
0043
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 2.9756e-05 - val_loss: 0.
0032
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 3.0002e-05 - val_loss: 0.
0041
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 3.1189e-05 - val_loss: 0.
0032
Epoch 9/20
144/144 [==============================] - 0s 2ms/step - loss: 3.0762e-05 - val_loss: 0.
0032
Epoch 10/20
144/144 [==============================] - 0s 2ms/step - loss: 2.9210e-05 - val_loss: 0.
0036
Epoch 11/20
144/144 [==============================] - 0s 2ms/step - loss: 3.3104e-05 - val_loss: 0.
0021
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 3.0628e-05 - val_loss: 0.
0026
Epoch 13/20
144/144 [==============================] - 0s 3ms/step - loss: 2.9184e-05 - val_loss: 0.
0020
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 2.6926e-05 - val_loss: 0.
0036
Epoch 15/20
144/144 [==============================] - 0s 3ms/step - loss: 2.8435e-05 - val_loss: 0.
0022
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 3.1793e-05 - val_loss: 0.
0032
Epoch 17/20
144/144 [==============================] - 0s 3ms/step - loss: 2.4808e-05 - val_loss: 0.
0020
Epoch 18/20
144/144 [==============================] - 0s 3ms/step - loss: 2.7344e-05 - val_loss: 0.
0016
Epoch 19/20
144/144 [==============================] - 0s 3ms/step - loss: 2.6830e-05 - val_loss: 0.
0022
Epoch 20/20
144/144 [==============================] - 0s 3ms/step - loss: 2.4836e-05 - val_loss: 0.
0024
Model trained and saved.
d:\ProgramFiles_Storage\anaconda3\Lib\site-packages\keras\src\engine\training.py:3103: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. This file form
at is considered legacy. We recommend using instead the native Keras format, e.g. `mode
l.save('my_model.keras')`.
  saving_api.save_model(
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\abc\predictions.csv.
```

LSTM Rolling Forecast
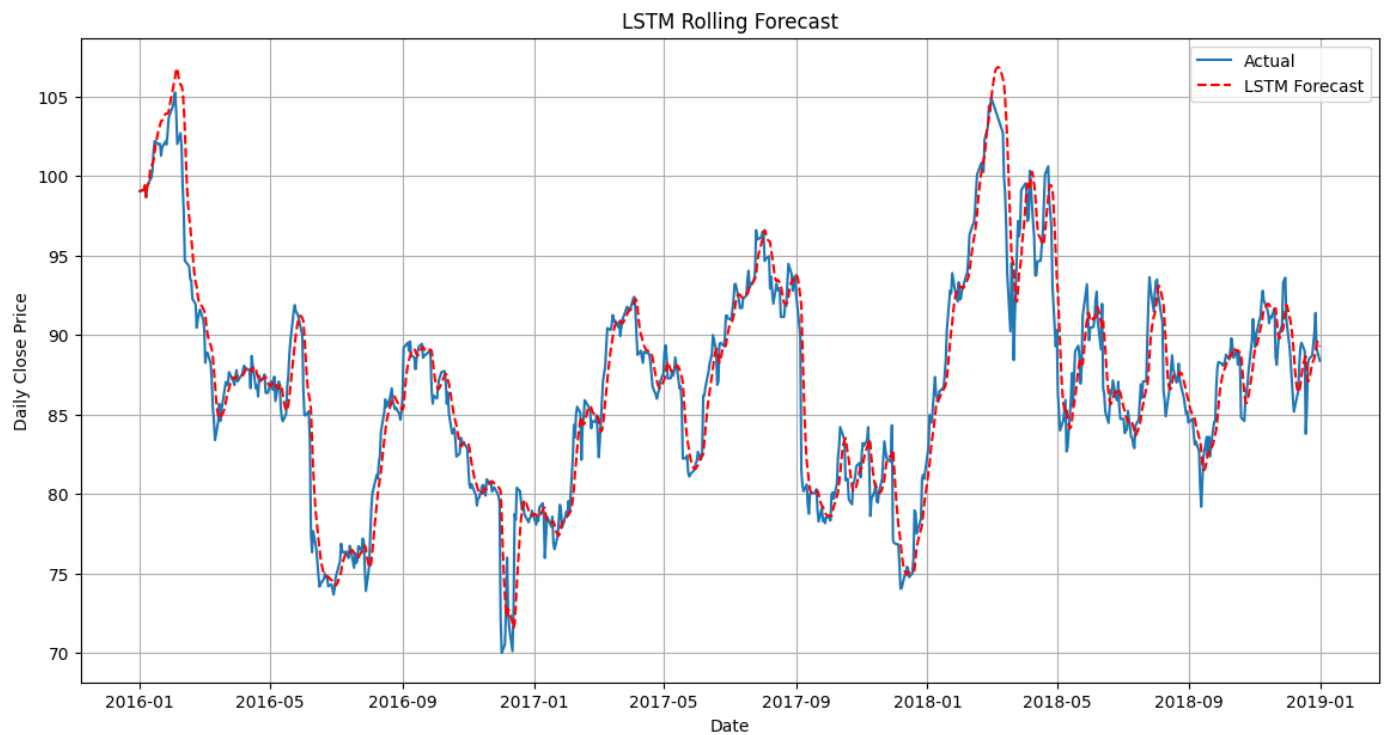
```
Processing abt...
Epoch 1/20
144/144 [==============================] - 3s 4ms/step - loss: 0.0117 - val_loss: 0.0096
Epoch 2/20
144/144 [==============================] - 0s 2ms/step - loss: 2.1913e-04 - val_loss: 0.
0046
Epoch 3/20
144/144 [==============================] - 0s 3ms/step - loss: 1.6736e-04 - val_loss: 0.
0012
Epoch 4/20
144/144 [==============================] - 0s 3ms/step - loss: 1.6233e-04 - val_loss: 0.
0014
Epoch 5/20
144/144 [==============================] - 0s 2ms/step - loss: 1.5910e-04 - val_loss: 0.
0013
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 1.5922e-04 - val_loss: 6.
2426e-04
Epoch 7/20
144/144 [==============================] - 0s 3ms/step - loss: 1.4773e-04 - val_loss: 6.
4102e-04
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 1.4007e-04 - val_loss: 7.
0838e-04
Epoch 9/20
144/144 [==============================] - 0s 2ms/step - loss: 1.3440e-04 - val_loss: 5.
0555e-04
Epoch 10/20
144/144 [==============================] - 0s 2ms/step - loss: 1.2932e-04 - val_loss: 3.
5034e-04
Epoch 11/20
144/144 [==============================] - 0s 2ms/step - loss: 1.2727e-04 - val_loss: 2.
7815e-04
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 1.2231e-04 - val_loss: 2.
9647e-04
Epoch 13/20
144/144 [==============================] - 0s 2ms/step - loss: 1.1497e-04 - val_loss: 3.
0082e-04
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 1.1645e-04 - val_loss: 4.
3140e-04
```

```
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 1.1166e-04 - val_loss: 4.
1775e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 1.0252e-04 - val_loss: 2.
1693e-04
Epoch 17/20
144/144 [==============================] - 0s 3ms/step - loss: 9.9589e-05 - val_loss: 1.
9753e-04
Epoch 18/20
144/144 [==============================] - 0s 3ms/step - loss: 1.0000e-04 - val_loss: 2.
0074e-04
Epoch 19/20
144/144 [==============================] - 0s 3ms/step - loss: 9.4926e-05 - val_loss: 2.
7162e-04
Epoch 20/20
144/144 [==============================] - 0s 3ms/step - loss: 9.2649e-05 - val_loss: 3.
7577e-04
Model trained and saved.
```

```
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\abt\predictions.csv.
```


LSTM Rolling Forecast

```
Processing acn...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0143 - val_loss: 0.0041
Epoch 2/20
144/144 [==============================] - 0s 2ms/step - loss: 1.2112e-04 - val_loss: 0.
0016
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 1.0929e-04 - val_loss: 0.
0011
Epoch 4/20
144/144 [==============================] - 0s 3ms/step - loss: 1.0693e-04 - val_loss: 7.
6604e-04
Epoch 5/20
144/144 [==============================] - 0s 3ms/step - loss: 1.0618e-04 - val_loss: 5.
```

```
3046e-04
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 1.0460e-04 - val_loss: 5.
1916e-04
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 1.0141e-04 - val_loss: 6.
8703e-04
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 9.5905e-05 - val_loss: 3.
7828e-04
Epoch 9/20
144/144 [==============================] - 0s 3ms/step - loss: 9.4976e-05 - val_loss: 4.
1727e-04
Epoch 10/20
144/144 [==============================] - 0s 3ms/step - loss: 9.0081e-05 - val_loss: 2.
6230e-04
Epoch 11/20
144/144 [==============================] - 0s 3ms/step - loss: 8.8373e-05 - val_loss: 3.
0659e-04
Epoch 12/20
144/144 [==============================] - 0s 3ms/step - loss: 8.3949e-05 - val_loss: 2.
3368e-04
Epoch 13/20
144/144 [==============================] - 0s 2ms/step - loss: 8.6552e-05 - val_loss: 2.
9899e-04
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 8.5645e-05 - val_loss: 1.
9948e-04
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 7.3408e-05 - val_loss: 1.
7367e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 8.1081e-05 - val_loss: 3.
9315e-04
Epoch 17/20
144/144 [==============================] - 0s 2ms/step - loss: 7.2094e-05 - val_loss: 1.
8942e-04
Epoch 18/20
144/144 [==============================] - 0s 3ms/step - loss: 7.3453e-05 - val_loss: 1.
5377e-04
Epoch 19/20
144/144 [==============================] - 0s 2ms/step - loss: 7.1132e-05 - val_loss: 1.
6082e-04
Epoch 20/20
144/144 [==============================] - 0s 2ms/step - loss: 6.8564e-05 - val_loss: 1.
3951e-04
Model trained and saved.
 1/34 [..............................] - ETA: 4s
d:\ProgramFiles_Storage\anaconda3\Lib\site-packages\keras\src\engine\training.py:3103: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. This file form
at is considered legacy. We recommend using instead the native Keras format, e.g. `mode
l.save('my_model.keras')`.
  saving_api.save_model(
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\acn\predictions.csv.
```
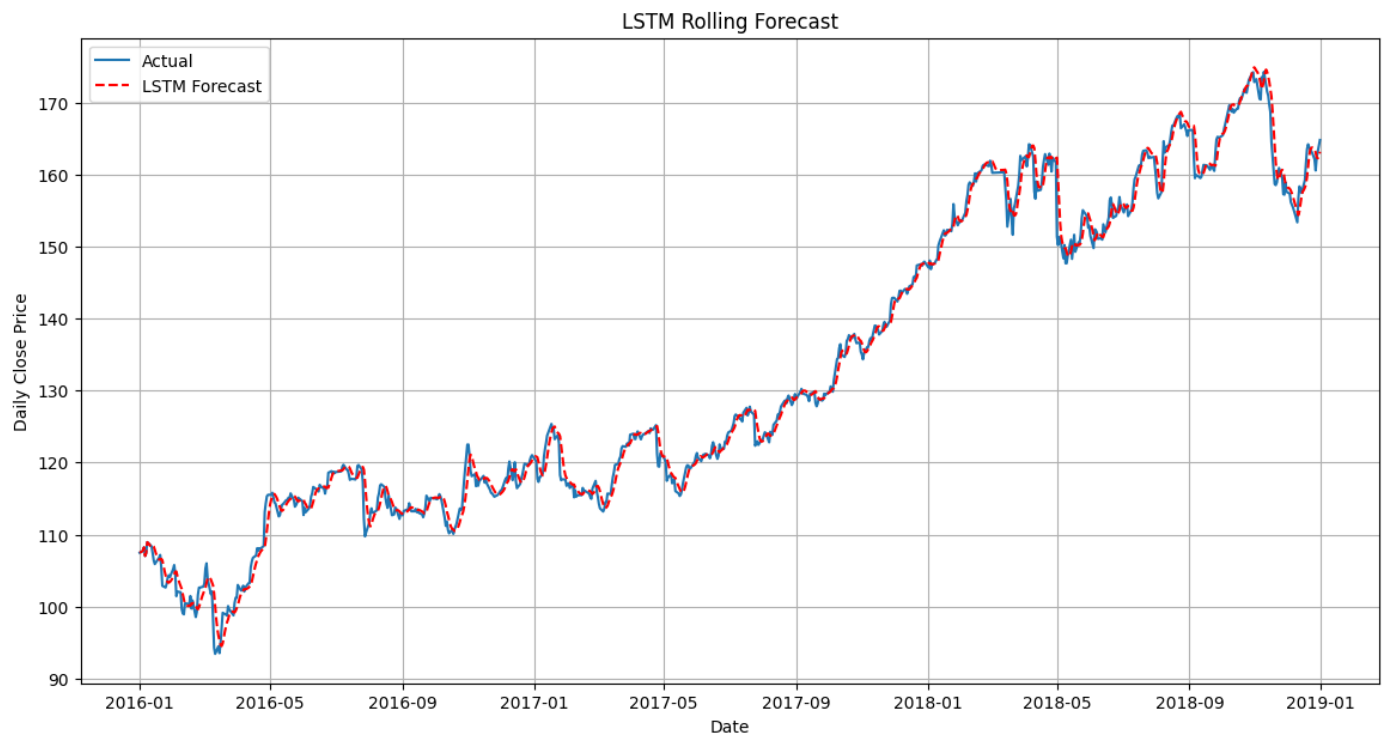
LSTM Rolling Forecast

```
Processing adbe...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0045 - val_loss: 6.8977
e-04
Epoch 2/20
144/144 [==============================] - 0s 2ms/step - loss: 1.1282e-04 - val_loss: 6.
7692e-04
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 1.0868e-04 - val_loss: 5.
3206e-04
Epoch 4/20
144/144 [==============================] - 0s 2ms/step - loss: 1.1014e-04 - val_loss: 4.
2849e-04
Epoch 5/20
144/144 [==============================] - 0s 2ms/step - loss: 1.0627e-04 - val_loss: 3.
2763e-04
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 1.0371e-04 - val_loss: 3.
6354e-04
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 1.0199e-04 - val_loss: 3.
4509e-04
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 9.0985e-05 - val_loss: 4.
3992e-04
Epoch 9/20
144/144 [==============================] - 0s 3ms/step - loss: 8.9594e-05 - val_loss: 4.
4855e-04
Epoch 10/20
144/144 [==============================] - 0s 3ms/step - loss: 8.7148e-05 - val_loss: 2.
4270e-04
Epoch 11/20
144/144 [==============================] - 0s 3ms/step - loss: 8.9704e-05 - val_loss: 2.
7759e-04
Epoch 12/20
144/144 [==============================] - 0s 3ms/step - loss: 7.9548e-05 - val_loss: 2.
1915e-04
Epoch 13/20
144/144 [==============================] - 0s 3ms/step - loss: 7.7342e-05 - val_loss: 2.
6770e-04
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 7.3822e-05 - val_loss: 2.
```

```
7541e-04
Epoch 15/20
144/144 [==============================] - 0s 3ms/step - loss: 7.0177e-05 - val_loss: 1.
8312e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 6.6628e-05 - val_loss: 1.
6416e-04
Epoch 17/20
144/144 [==============================] - 0s 2ms/step - loss: 6.7359e-05 - val_loss: 1.
8681e-04
Epoch 18/20
144/144 [==============================] - 0s 3ms/step - loss: 6.8921e-05 - val_loss: 2.
4642e-04
Epoch 19/20
144/144 [==============================] - 0s 2ms/step - loss: 6.5695e-05 - val_loss: 2.
4365e-04
Epoch 20/20
144/144 [==============================] - 0s 2ms/step - loss: 6.4391e-05 - val_loss: 3.
2184e-04
Model trained and saved.
  1/34 [..............................] - ETA: 5s
d:\ProgramFiles_Storage\anaconda3\Lib\site-packages\keras\src\engine\training.py:3103: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. This file form
at is considered legacy. We recommend using instead the native Keras format, e.g. `mode
l.save('my_model.keras')`.
  saving_api.save_model(
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\adbe\predictions.csv.
```
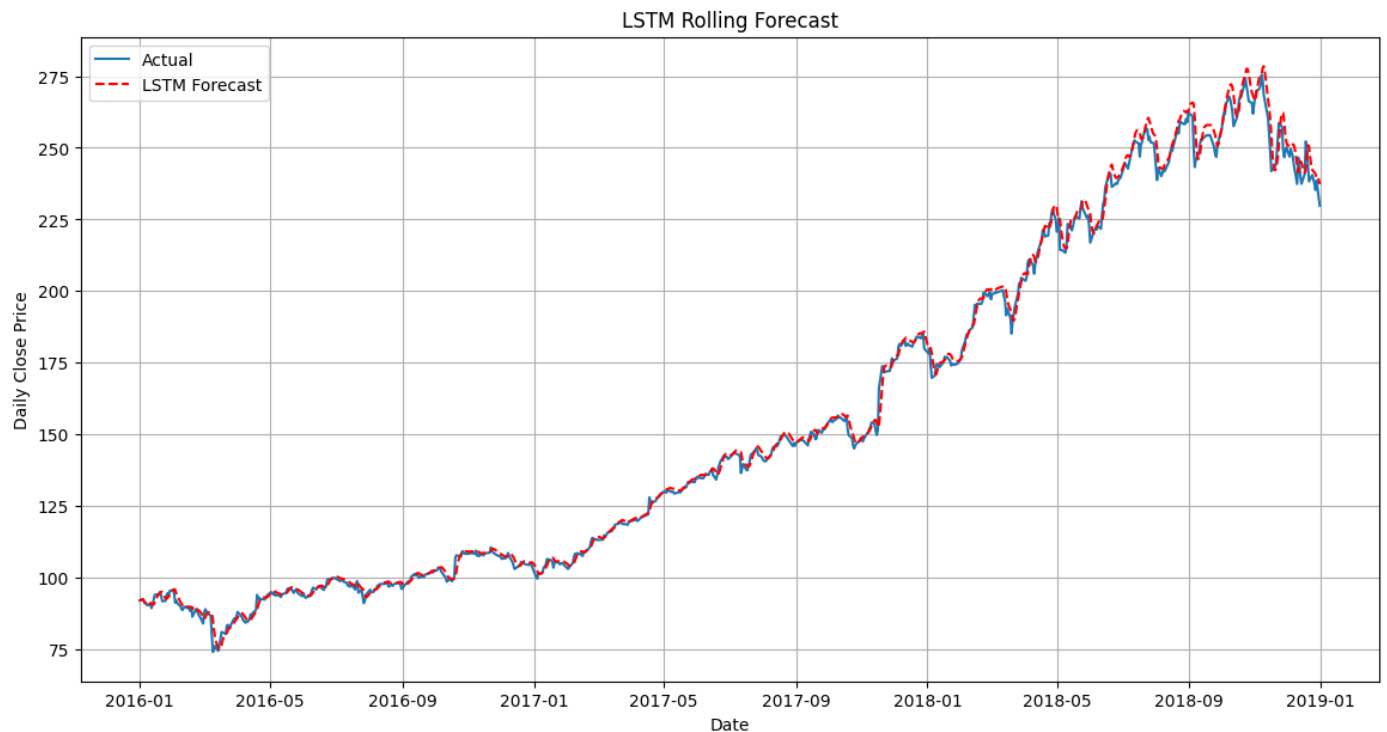

LSTM Rolling Forecast

```
Processing adi...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0179 - val_loss: 0.0017
Epoch 2/20
144/144 [==============================] - 0s 2ms/step - loss: 3.3878e-04 - val_loss: 8.
1388e-04
Epoch 3/20
144/144 [==============================] - 0s 3ms/step - loss: 3.2446e-04 - val_loss: 0.
0018
Epoch 4/20
144/144 [==============================] - 0s 2ms/step - loss: 3.1569e-04 - val_loss: 6.
5090e-04
Epoch 5/20
```

```
144/144 [==============================] - 0s 2ms/step - loss: 2.9915e-04 - val_loss: 6.
5805e-04
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 2.7901e-04 - val_loss: 8.
0876e-04
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 2.7450e-04 - val_loss: 7.
3583e-04
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 2.6370e-04 - val_loss: 8.
1408e-04
Epoch 9/20
144/144 [==============================] - 0s 3ms/step - loss: 2.4930e-04 - val_loss: 5.
3942e-04
Epoch 10/20
144/144 [==============================] - 0s 2ms/step - loss: 2.3985e-04 - val_loss: 5.
5419e-04
Epoch 11/20
144/144 [==============================] - 0s 2ms/step - loss: 2.1684e-04 - val_loss: 3.
5716e-04
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 2.0139e-04 - val_loss: 0.
0012
Epoch 13/20
144/144 [==============================] - 0s 2ms/step - loss: 2.1473e-04 - val_loss: 5.
3119e-04
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 2.0031e-04 - val_loss: 3.
0036e-04
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8733e-04 - val_loss: 3.
1885e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8108e-04 - val_loss: 3.
6012e-04
Epoch 17/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8055e-04 - val_loss: 2.
6474e-04
Epoch 18/20
144/144 [==============================] - 0s 3ms/step - loss: 1.6345e-04 - val_loss: 2.
2620e-04
Epoch 19/20
144/144 [==============================] - 0s 3ms/step - loss: 1.6769e-04 - val_loss: 2.
5858e-04
Epoch 20/20
144/144 [==============================] - 0s 2ms/step - loss: 1.5860e-04 - val_loss: 2.
1301e-04
Model trained and saved.
d:\ProgramFiles_Storage\anaconda3\Lib\site-packages\keras\src\engine\training.py:3103: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. This file form
at is considered legacy. We recommend using instead the native Keras format, e.g. `mode
l.save('my_model.keras')`.
  saving_api.save_model(
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\adi\predictions.csv.
```

LSTM Rolling Forecast
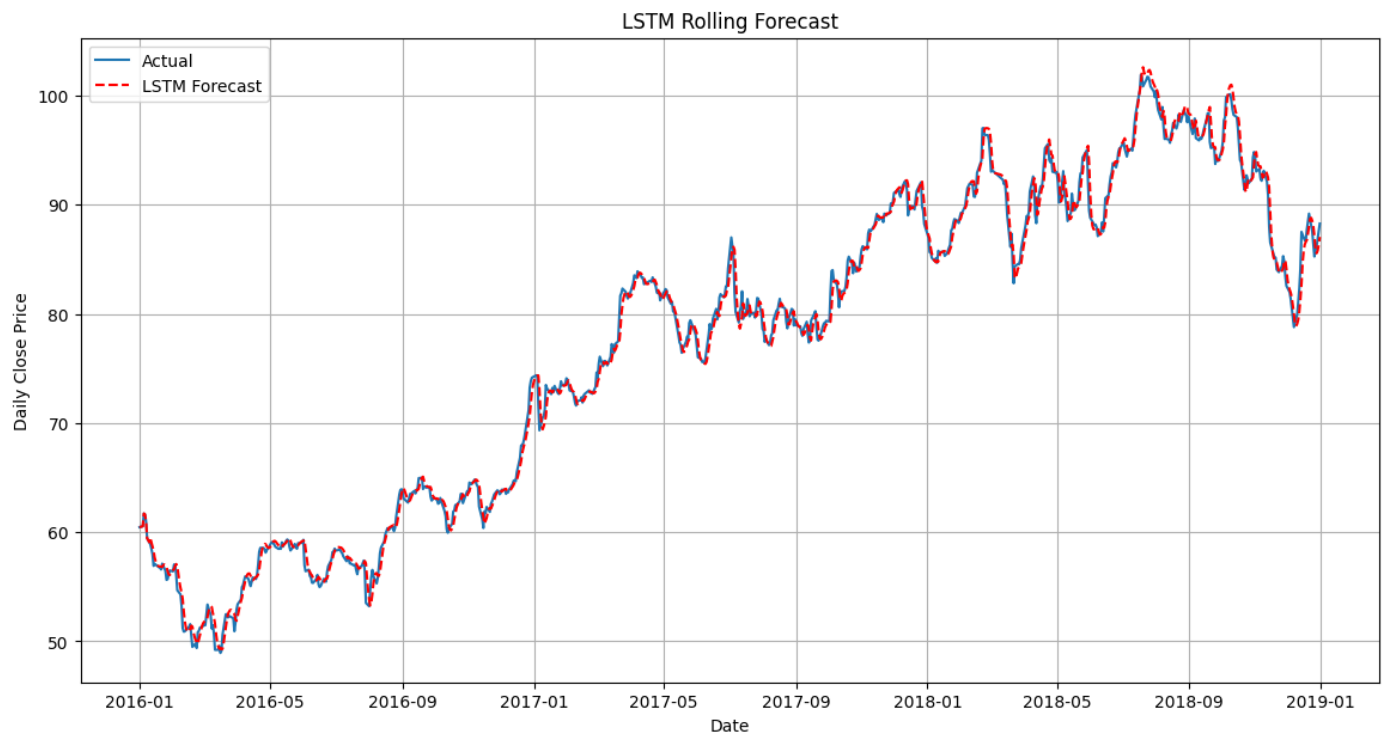
```
Processing adm...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0457 - val_loss: 0.0041
Epoch 2/20
144/144 [==============================] - 0s 2ms/step - loss: 3.8450e-04 - val_loss: 0.
0014
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 3.4747e-04 - val_loss: 0.
0017
Epoch 4/20
144/144 [==============================] - 0s 2ms/step - loss: 3.3493e-04 - val_loss: 0.
0010
Epoch 5/20
144/144 [==============================] - 0s 2ms/step - loss: 3.0901e-04 - val_loss: 8.
0234e-04
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 2.9460e-04 - val_loss: 9.
1122e-04
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 2.5945e-04 - val_loss: 4.
4728e-04
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 2.4273e-04 - val_loss: 3.
3326e-04
Epoch 9/20
144/144 [==============================] - 0s 2ms/step - loss: 2.1643e-04 - val_loss: 5.
3110e-04
Epoch 10/20
144/144 [==============================] - 0s 2ms/step - loss: 2.1766e-04 - val_loss: 2.
6451e-04
Epoch 11/20
144/144 [==============================] - 0s 3ms/step - loss: 1.9684e-04 - val_loss: 2.
0988e-04
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 1.9321e-04 - val_loss: 1.
9531e-04
Epoch 13/20
144/144 [==============================] - 0s 2ms/step - loss: 1.9020e-04 - val_loss: 4.
9839e-04
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8448e-04 - val_loss: 2.
0030e-04
```

```
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8067e-04 - val_loss: 2.
1880e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 1.7783e-04 - val_loss: 1.
7306e-04
Epoch 17/20
144/144 [==============================] - 0s 2ms/step - loss: 1.7934e-04 - val_loss: 2.
2165e-04
Epoch 18/20
144/144 [==============================] - 0s 2ms/step - loss: 1.6452e-04 - val_loss: 1.
8143e-04
Epoch 19/20
144/144 [==============================] - 0s 2ms/step - loss: 1.6173e-04 - val_loss: 1.
5512e-04
Epoch 20/20
144/144 [==============================] - 0s 2ms/step - loss: 1.6988e-04 - val_loss: 2.
1277e-04
Model trained and saved.
 1/34 [..............................] - ETA: 5s
```
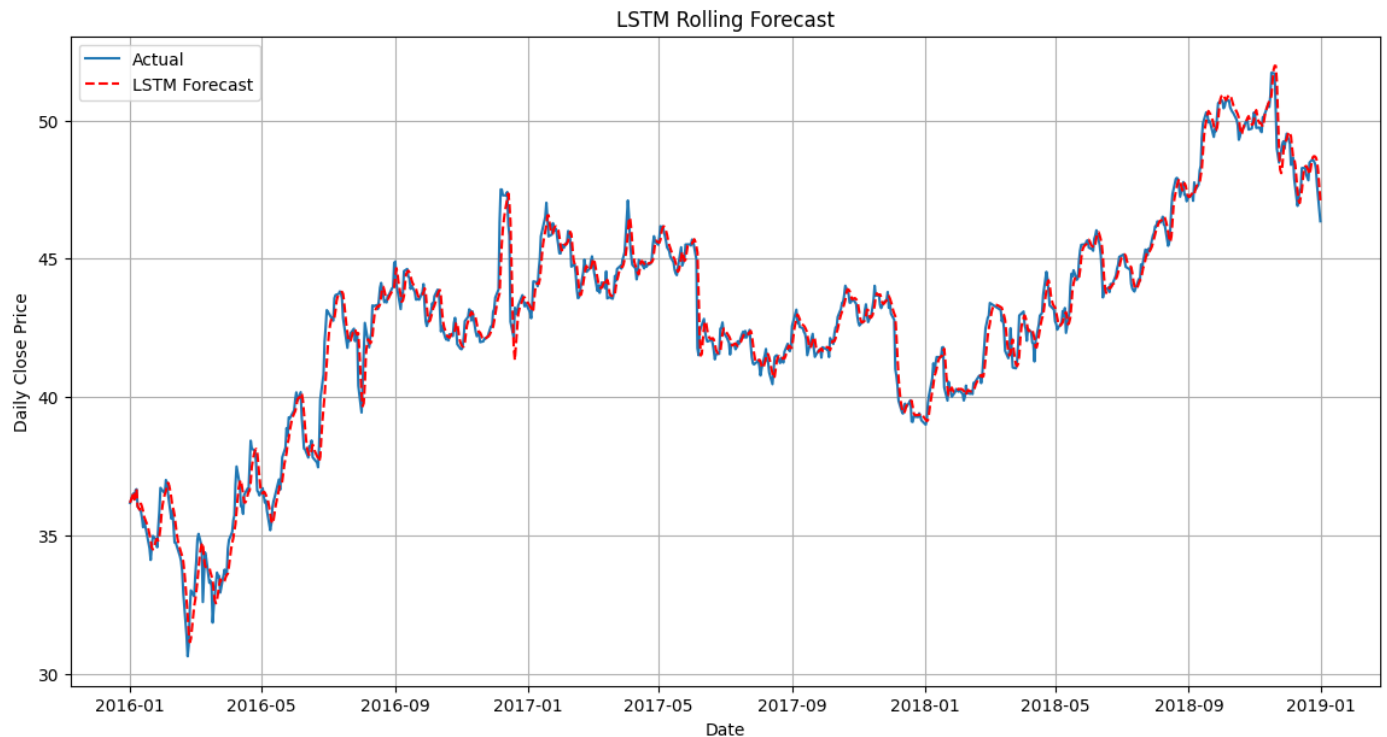
d:\ProgramFiles_Storage\anaconda3\Lib\site-packages\keras\src\engine\training.py:3103: UserWarning: You are saving your model as an HDF5 file via `model.save()`. This file format is considered legacy. We recommend using instead the native Keras format, e.g. `model.save('my_model.keras')`.
  saving_api.save_model(

```
34/34 [==============================] - 0s 2ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\adm\predictions.csv.
```


LSTM Rolling Forecast

```
Processing adp...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0166 - val_loss: 0.0106
Epoch 2/20
144/144 [==============================] - 0s 2ms/step - loss: 1.2697e-04 - val_loss: 0.
0064
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 1.1900e-04 - val_loss: 0.
0043
Epoch 4/20
144/144 [==============================] - 0s 2ms/step - loss: 1.0966e-04 - val_loss: 0.
0045
Epoch 5/20
```

```
144/144 [==============================] - 0s 2ms/step - loss: 1.1263e-04 - val_loss: 0.
0024
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 1.0560e-04 - val_loss: 0.
0018
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 1.0070e-04 - val_loss: 0.
0017
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 1.0462e-04 - val_loss: 0.
0014
Epoch 9/20
144/144 [==============================] - 0s 2ms/step - loss: 9.2577e-05 - val_loss: 9.
3860e-04
Epoch 10/20
144/144 [==============================] - 0s 2ms/step - loss: 8.5731e-05 - val_loss: 0.
0014
Epoch 11/20
144/144 [==============================] - 0s 2ms/step - loss: 8.0876e-05 - val_loss: 7.
4682e-04
Epoch 12/20
144/144 [==============================] - 0s 3ms/step - loss: 7.7563e-05 - val_loss: 9.
2655e-04
Epoch 13/20
144/144 [==============================] - 0s 3ms/step - loss: 6.6079e-05 - val_loss: 2.
6892e-04
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 6.7668e-05 - val_loss: 4.
8406e-04
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 5.8986e-05 - val_loss: 2.
7627e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 6.2303e-05 - val_loss: 1.
6399e-04
Epoch 17/20
144/144 [==============================] - 0s 2ms/step - loss: 5.4883e-05 - val_loss: 1.
5690e-04
Epoch 18/20
144/144 [==============================] - 0s 2ms/step - loss: 6.1672e-05 - val_loss: 1.
8636e-04
Epoch 19/20
144/144 [==============================] - 0s 2ms/step - loss: 5.6377e-05 - val_loss: 2.
9009e-04
Epoch 20/20
144/144 [==============================] - 0s 2ms/step - loss: 5.5570e-05 - val_loss: 1.
6933e-04
Model trained and saved.
 1/34 [.............................] - ETA: 4s
d:\ProgramFiles_Storage\anaconda3\Lib\site-packages\keras\src\engine\training.py:3103: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. This file form
at is considered legacy. We recommend using instead the native Keras format, e.g. `mode
l.save('my_model.keras')`.
  saving_api.save_model(
34/34 [==============================] - 0s 3ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\adp\predictions.csv.
```
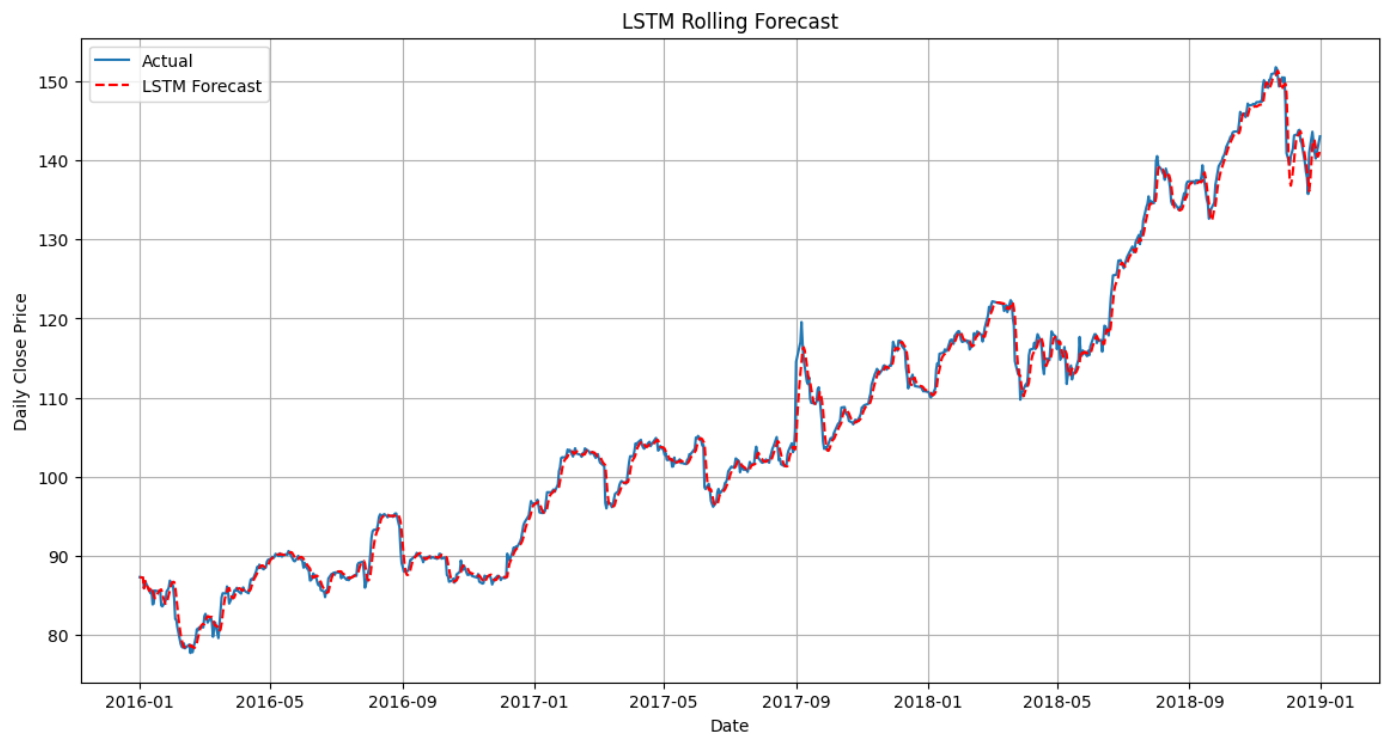
LSTM Rolling Forecast

```
Processing ads...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0129 - val_loss: 0.0031
Epoch 2/20
144/144 [==============================] - 0s 3ms/step - loss: 1.2483e-04 - val_loss: 7.
2269e-04
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 9.6104e-05 - val_loss: 6.
3718e-04
Epoch 4/20
144/144 [==============================] - 0s 2ms/step - loss: 9.6296e-05 - val_loss: 6.
0946e-04
Epoch 5/20
144/144 [==============================] - 0s 2ms/step - loss: 8.9029e-05 - val_loss: 7.
9079e-04
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 8.8978e-05 - val_loss: 7.
5365e-04
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 8.5225e-05 - val_loss: 7.
2277e-04
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 8.3590e-05 - val_loss: 5.
2156e-04
Epoch 9/20
144/144 [==============================] - 0s 2ms/step - loss: 8.2786e-05 - val_loss: 4.
9109e-04
Epoch 10/20
144/144 [==============================] - 0s 2ms/step - loss: 8.6804e-05 - val_loss: 5.
0196e-04
Epoch 11/20
144/144 [==============================] - 0s 3ms/step - loss: 8.7122e-05 - val_loss: 6.
4212e-04
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 8.0657e-05 - val_loss: 5.
5374e-04
Epoch 13/20
144/144 [==============================] - 0s 2ms/step - loss: 7.6550e-05 - val_loss: 5.
0773e-04
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 7.7025e-05 - val_loss: 4.
8823e-04
```

```
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 7.6992e-05 - val_loss: 4.
6878e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 7.7622e-05 - val_loss: 4.
9965e-04
Epoch 17/20
144/144 [==============================] - 0s 3ms/step - loss: 7.1473e-05 - val_loss: 4.
0986e-04
Epoch 18/20
144/144 [==============================] - 0s 2ms/step - loss: 7.6730e-05 - val_loss: 6.
8362e-04
Epoch 19/20
144/144 [==============================] - 0s 2ms/step - loss: 8.7867e-05 - val_loss: 8.
4488e-04
Epoch 20/20
144/144 [==============================] - 0s 2ms/step - loss: 7.3611e-05 - val_loss: 3.
8383e-04
Model trained and saved.
```

```
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\ads\predictions.csv.
```
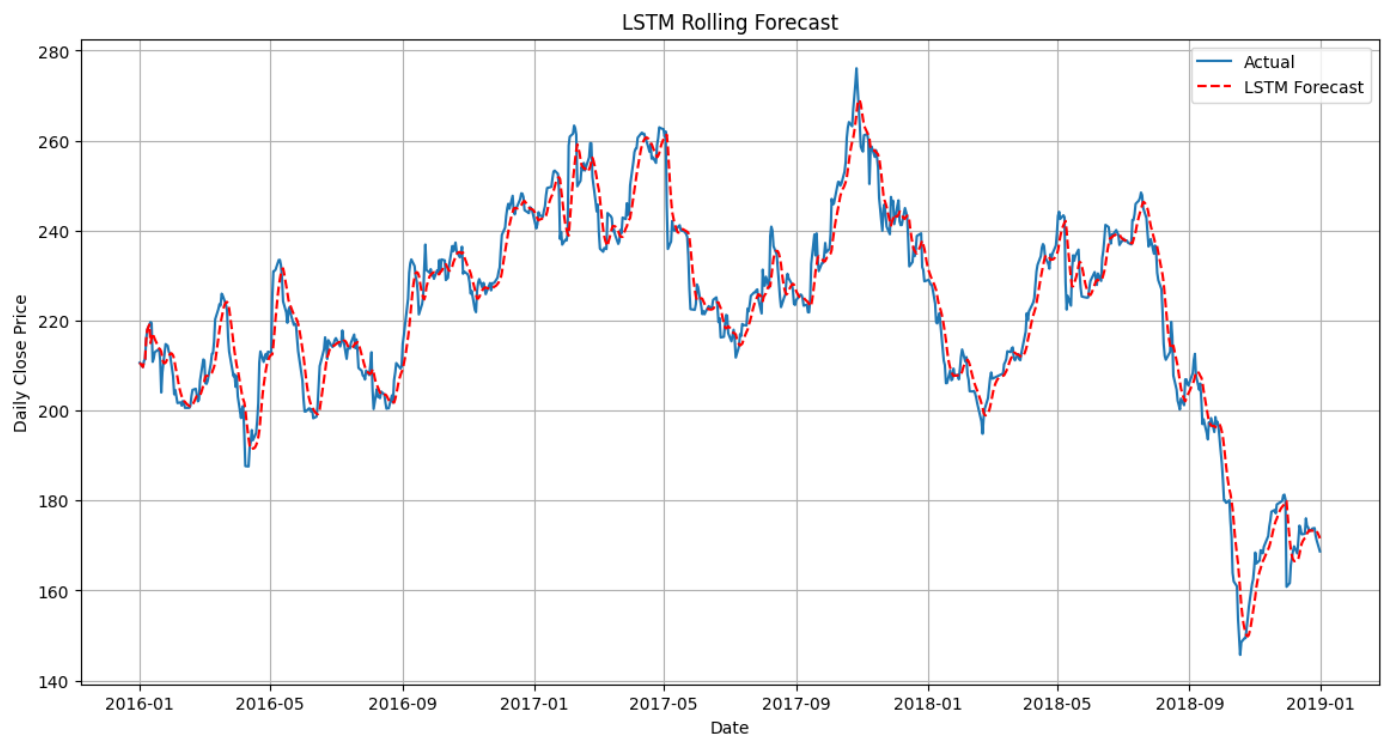


```
Processing adsk...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0346 - val_loss: 0.0027
Epoch 2/20
144/144 [==============================] - 0s 2ms/step - loss: 2.3801e-04 - val_loss: 8.
4564e-04
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 2.2293e-04 - val_loss: 4.
2126e-04
Epoch 4/20
144/144 [==============================] - 0s 3ms/step - loss: 2.1169e-04 - val_loss: 3.
6970e-04
Epoch 5/20
144/144 [==============================] - 0s 2ms/step - loss: 2.0922e-04 - val_loss: 3.
6399e-04
```

```
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 1.9759e-04 - val_loss: 3.
4777e-04
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8541e-04 - val_loss: 3.
5671e-04
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 2.0600e-04 - val_loss: 4.
6120e-04
Epoch 9/20
144/144 [==============================] - 0s 2ms/step - loss: 1.7120e-04 - val_loss: 2.
9721e-04
Epoch 10/20
144/144 [==============================] - 0s 2ms/step - loss: 1.7414e-04 - val_loss: 2.
6583e-04
Epoch 11/20
144/144 [==============================] - 0s 3ms/step - loss: 1.6323e-04 - val_loss: 2.
4651e-04
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 1.7814e-04 - val_loss: 9.
6704e-04
Epoch 13/20
144/144 [==============================] - 0s 2ms/step - loss: 1.6492e-04 - val_loss: 2.
5107e-04
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 1.5383e-04 - val_loss: 4.
5396e-04
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 1.5695e-04 - val_loss: 2.
5846e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 1.4467e-04 - val_loss: 2.
1825e-04
Epoch 17/20
144/144 [==============================] - 0s 2ms/step - loss: 1.3130e-04 - val_loss: 1.
9394e-04
Epoch 18/20
144/144 [==============================] - 0s 2ms/step - loss: 1.4329e-04 - val_loss: 1.
9400e-04
Epoch 19/20
144/144 [==============================] - 0s 2ms/step - loss: 1.3416e-04 - val_loss: 2.
1240e-04
Epoch 20/20
144/144 [==============================] - 0s 2ms/step - loss: 1.2903e-04 - val_loss: 2.
2506e-04
Model trained and saved.
d:\ProgramFiles_Storage\anaconda3\Lib\site-packages\keras\src\engine\training.py:3103: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. This file form
at is considered legacy. We recommend using instead the native Keras format, e.g. `mode
l.save('my_model.keras')`.
  saving_api.save_model(
34/34 [==============================] - 0s 2ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\adsk\predictions.csv.
```

LSTM Rolling Forecast
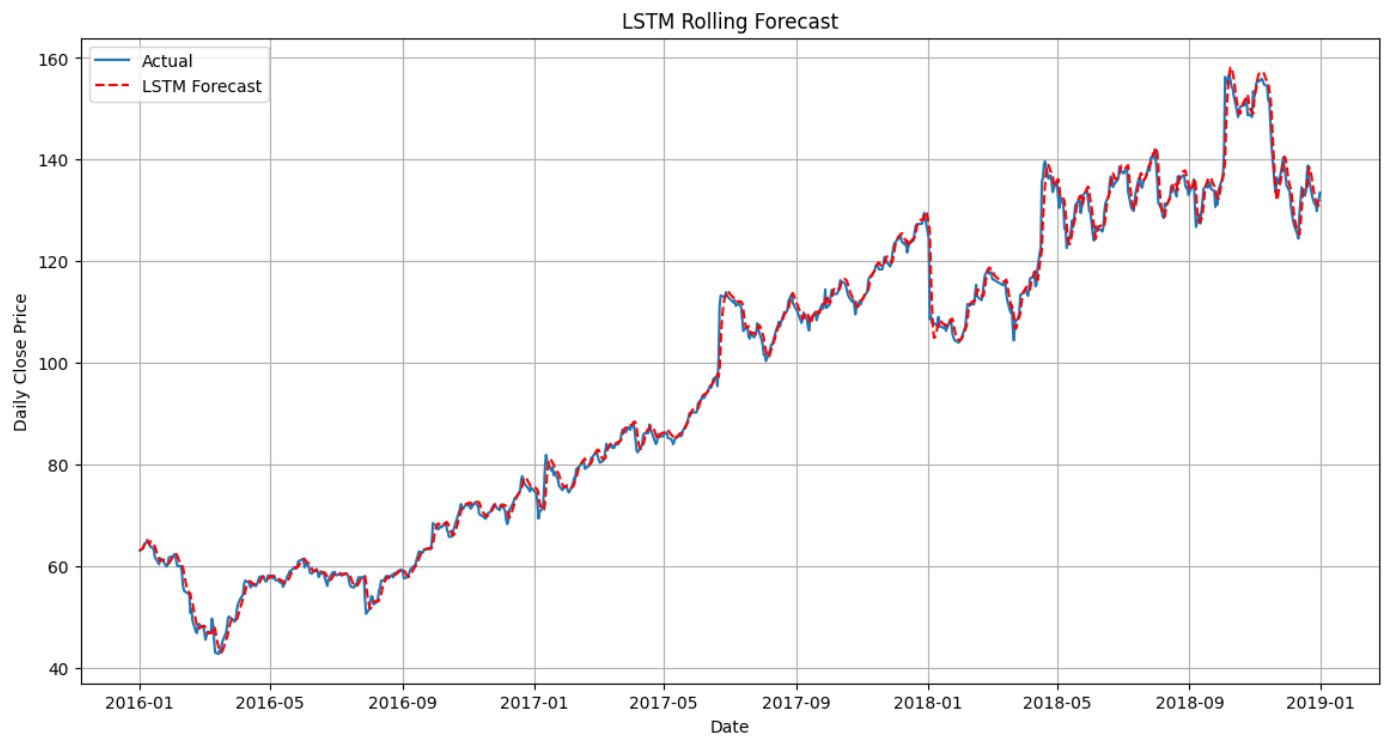
```
Processing aee...
Epoch 1/20
144/144 [==============================] - 3s 4ms/step - loss: 0.0445 - val_loss: 6.1020
e-04
Epoch 2/20
144/144 [==============================] - 0s 2ms/step - loss: 3.8595e-04 - val_loss: 3.
4542e-04
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 3.3433e-04 - val_loss: 3.
6372e-04
Epoch 4/20
144/144 [==============================] - 0s 2ms/step - loss: 3.0903e-04 - val_loss: 3.
3790e-04
Epoch 5/20
144/144 [==============================] - 0s 2ms/step - loss: 3.0031e-04 - val_loss: 2.
7448e-04
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 2.7312e-04 - val_loss: 3.
3676e-04
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 2.5876e-04 - val_loss: 2.
5984e-04
Epoch 8/20
144/144 [==============================] - 0s 3ms/step - loss: 2.4333e-04 - val_loss: 2.
1843e-04
Epoch 9/20
144/144 [==============================] - 0s 3ms/step - loss: 2.2104e-04 - val_loss: 1.
9851e-04
Epoch 10/20
144/144 [==============================] - 0s 3ms/step - loss: 2.0879e-04 - val_loss: 1.
9926e-04
Epoch 11/20
144/144 [==============================] - 0s 2ms/step - loss: 2.0294e-04 - val_loss: 1.
7401e-04
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8790e-04 - val_loss: 1.
8566e-04
Epoch 13/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8520e-04 - val_loss: 1.
5725e-04
Epoch 14/20
144/144 [==============================] - 0s 3ms/step - loss: 1.8058e-04 - val_loss: 1.
```

```
6064e-04
Epoch 15/20
144/144 [==============================] - 0s 3ms/step - loss: 1.7613e-04 - val_loss: 1.
5479e-04
Epoch 16/20
144/144 [==============================] - 0s 3ms/step - loss: 1.7970e-04 - val_loss: 1.
4579e-04
Epoch 17/20
144/144 [==============================] - 0s 3ms/step - loss: 1.6895e-04 - val_loss: 1.
4456e-04
Epoch 18/20
144/144 [==============================] - 0s 2ms/step - loss: 1.6835e-04 - val_loss: 1.
4566e-04
Epoch 19/20
144/144 [==============================] - 0s 3ms/step - loss: 1.5997e-04 - val_loss: 1.
6028e-04
Epoch 20/20
144/144 [==============================] - 0s 3ms/step - loss: 1.6617e-04 - val_loss: 1.
3721e-04
Model trained and saved.
  1/34 [..............................] - ETA: 5s
```

```
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\aee\predictions.csv.
```


LSTM Rolling Forecast
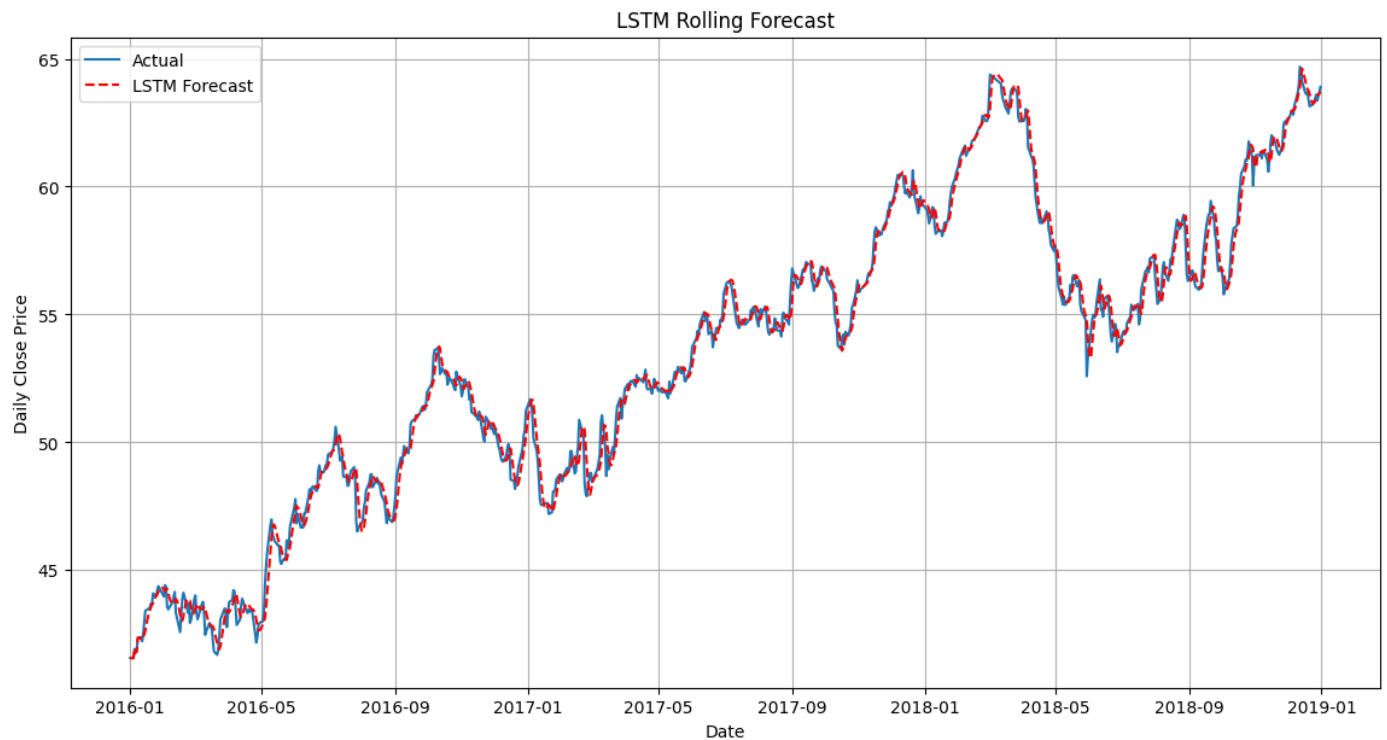
```
Processing aep...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0375 - val_loss: 0.0048
Epoch 2/20
144/144 [==============================] - 0s 2ms/step - loss: 3.1625e-04 - val_loss: 0.
0014
Epoch 3/20
144/144 [==============================] - 0s 3ms/step - loss: 2.8323e-04 - val_loss: 0.
0011
Epoch 4/20
144/144 [==============================] - 0s 3ms/step - loss: 2.7089e-04 - val_loss: 7.
8907e-04
```

```
Epoch 5/20
144/144 [==============================] - 0s 3ms/step - loss: 2.5650e-04 - val_loss: 6.
3662e-04
Epoch 6/20
144/144 [==============================] - 0s 3ms/step - loss: 2.4486e-04 - val_loss: 5.
4673e-04
Epoch 7/20
144/144 [==============================] - 0s 3ms/step - loss: 2.3064e-04 - val_loss: 7.
8266e-04
Epoch 8/20
144/144 [==============================] - 0s 3ms/step - loss: 2.1470e-04 - val_loss: 4.
6338e-04
Epoch 9/20
144/144 [==============================] - 0s 3ms/step - loss: 1.9639e-04 - val_loss: 5.
7727e-04
Epoch 10/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8351e-04 - val_loss: 4.
2559e-04
Epoch 11/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8014e-04 - val_loss: 5.
1382e-04
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 1.6436e-04 - val_loss: 2.
3419e-04
Epoch 13/20
144/144 [==============================] - 0s 2ms/step - loss: 1.5763e-04 - val_loss: 4.
5893e-04
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 1.4887e-04 - val_loss: 2.
0594e-04
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 1.4118e-04 - val_loss: 2.
4291e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 1.4361e-04 - val_loss: 2.
4710e-04
Epoch 17/20
144/144 [==============================] - 0s 2ms/step - loss: 1.3411e-04 - val_loss: 1.
8340e-04
Epoch 18/20
144/144 [==============================] - 0s 3ms/step - loss: 1.2789e-04 - val_loss: 1.
7696e-04
Epoch 19/20
144/144 [==============================] - 0s 2ms/step - loss: 1.2492e-04 - val_loss: 2.
5904e-04
Epoch 20/20
144/144 [==============================] - 0s 2ms/step - loss: 1.2035e-04 - val_loss: 1.
5323e-04
Model trained and saved.
 1/34 [..............................] - ETA: 5s
d:\ProgramFiles_Storage\anaconda3\Lib\site-packages\keras\src\engine\training.py:3103: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. This file form
at is considered legacy. We recommend using instead the native Keras format, e.g. `mode
l.save('my_model.keras')`.
  saving_api.save_model(
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\aep\predictions.csv.
```
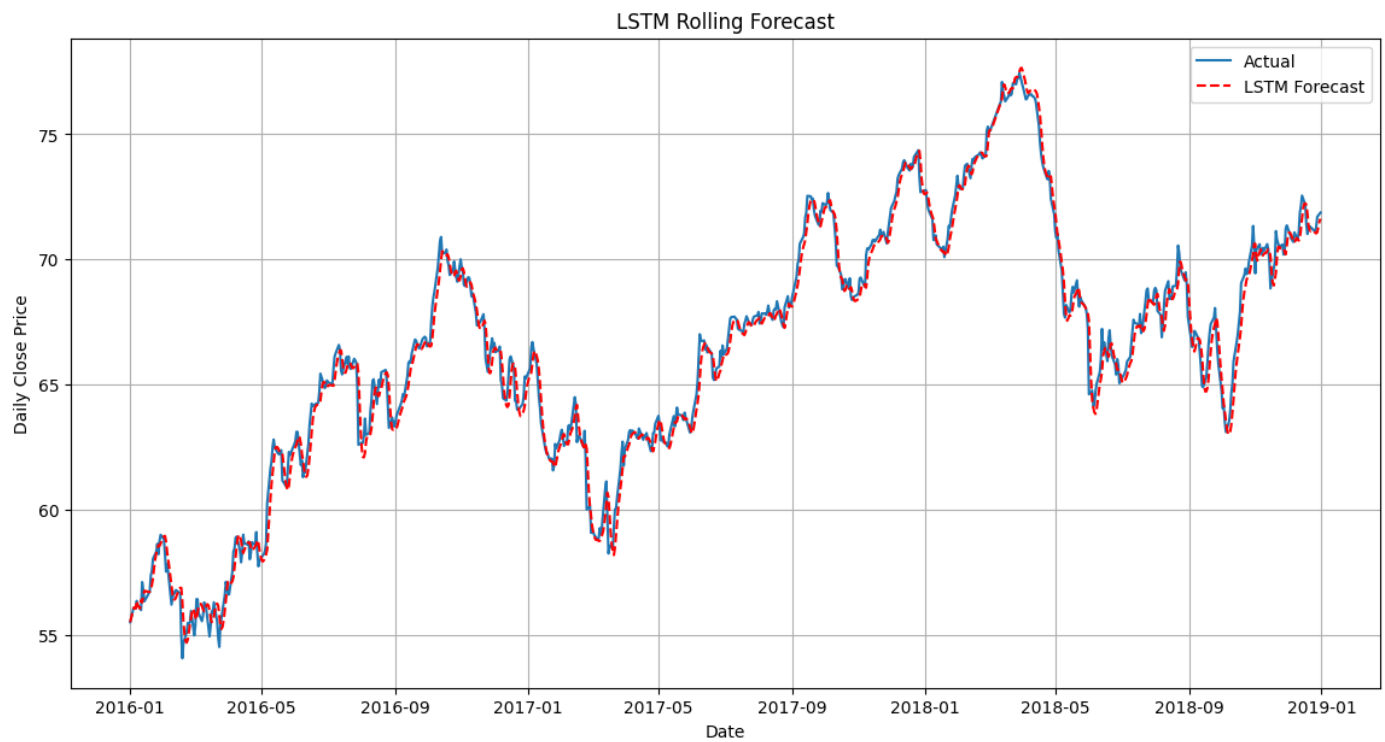
LSTM Rolling Forecast

```
Processing aes...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0529 - val_loss: 1.9872
e-04
Epoch 2/20
144/144 [==============================] - 0s 2ms/step - loss: 4.0257e-04 - val_loss: 1.
5730e-04
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 3.4916e-04 - val_loss: 1.
4071e-04
Epoch 4/20
144/144 [==============================] - 0s 2ms/step - loss: 3.2159e-04 - val_loss: 1.
1175e-04
Epoch 5/20
144/144 [==============================] - 0s 2ms/step - loss: 3.1160e-04 - val_loss: 1.
1126e-04
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 2.8303e-04 - val_loss: 1.
1170e-04
Epoch 7/20
144/144 [==============================] - 0s 3ms/step - loss: 2.7390e-04 - val_loss: 9.
3887e-05
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 2.4496e-04 - val_loss: 8.
1473e-05
Epoch 9/20
144/144 [==============================] - 0s 2ms/step - loss: 2.1977e-04 - val_loss: 1.
5962e-04
Epoch 10/20
144/144 [==============================] - 0s 2ms/step - loss: 2.0836e-04 - val_loss: 8.
5266e-05
Epoch 11/20
144/144 [==============================] - 0s 2ms/step - loss: 1.9538e-04 - val_loss: 8.
9907e-05
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8777e-04 - val_loss: 6.
9092e-05
Epoch 13/20
144/144 [==============================] - 0s 2ms/step - loss: 1.7702e-04 - val_loss: 1.
6839e-04
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 1.7910e-04 - val_loss: 5.
```

```
8715e-05
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 1.6413e-04 - val_loss: 7.
8645e-05
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 1.6648e-04 - val_loss: 8.
1032e-05
Epoch 17/20
144/144 [==============================] - 0s 2ms/step - loss: 1.5046e-04 - val_loss: 6.
0535e-05
Epoch 18/20
144/144 [==============================] - 0s 2ms/step - loss: 1.6147e-04 - val_loss: 6.
2282e-05
Epoch 19/20
144/144 [==============================] - 0s 2ms/step - loss: 1.3998e-04 - val_loss: 7.
5779e-05
Epoch 20/20
144/144 [==============================] - 0s 2ms/step - loss: 1.4401e-04 - val_loss: 5.
5083e-05
Model trained and saved.
```

```
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\aes\predictions.csv.
```


LSTM Rolling Forecast
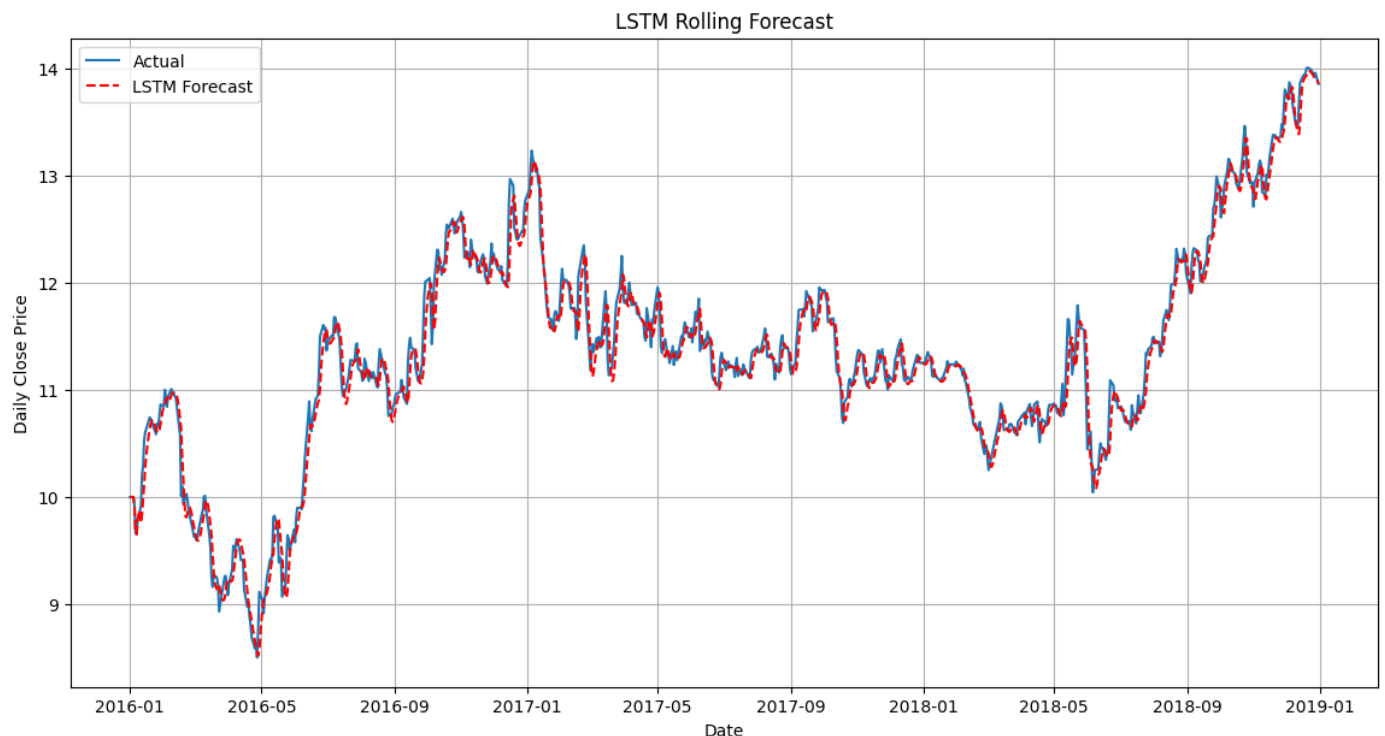
```
Processing afl...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0501 - val_loss: 3.4397
e-04
Epoch 2/20
144/144 [==============================] - 0s 2ms/step - loss: 6.2528e-04 - val_loss: 2.
8582e-04
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 5.1584e-04 - val_loss: 2.
6065e-04
Epoch 4/20
144/144 [==============================] - 0s 3ms/step - loss: 4.8655e-04 - val_loss: 2.
7781e-04
```

```
Epoch 5/20
144/144 [==============================] - 0s 3ms/step - loss: 4.5687e-04 - val_loss: 2.
1807e-04
Epoch 6/20
144/144 [==============================] - 0s 3ms/step - loss: 4.4318e-04 - val_loss: 4.
7258e-04
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 4.2706e-04 - val_loss: 2.
0339e-04
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 3.9730e-04 - val_loss: 1.
8569e-04
Epoch 9/20
144/144 [==============================] - 0s 2ms/step - loss: 3.6676e-04 - val_loss: 2.
9125e-04
Epoch 10/20
144/144 [==============================] - 0s 2ms/step - loss: 3.4972e-04 - val_loss: 1.
5467e-04
Epoch 11/20
144/144 [==============================] - 0s 2ms/step - loss: 3.2076e-04 - val_loss: 2.
8028e-04
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 3.0692e-04 - val_loss: 1.
1948e-04
Epoch 13/20
144/144 [==============================] - 0s 2ms/step - loss: 3.1115e-04 - val_loss: 1.
2143e-04
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 2.8852e-04 - val_loss: 2.
7303e-04
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 2.9027e-04 - val_loss: 1.
0679e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 3.0447e-04 - val_loss: 1.
0549e-04
Epoch 17/20
144/144 [==============================] - 0s 2ms/step - loss: 2.6305e-04 - val_loss: 1.
1182e-04
Epoch 18/20
144/144 [==============================] - 0s 2ms/step - loss: 2.5339e-04 - val_loss: 1.
1266e-04
Epoch 19/20
144/144 [==============================] - 0s 3ms/step - loss: 2.5059e-04 - val_loss: 9.
3229e-05
Epoch 20/20
144/144 [==============================] - 0s 3ms/step - loss: 2.5163e-04 - val_loss: 8.
7159e-05
Model trained and saved.
d:\ProgramFiles_Storage\anaconda3\Lib\site-packages\keras\src\engine\training.py:3103: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. This file form
at is considered legacy. We recommend using instead the native Keras format, e.g. `mode
l.save('my_model.keras')`.
  saving_api.save_model(
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\afl\predictions.csv.
```

LSTM Rolling Forecast
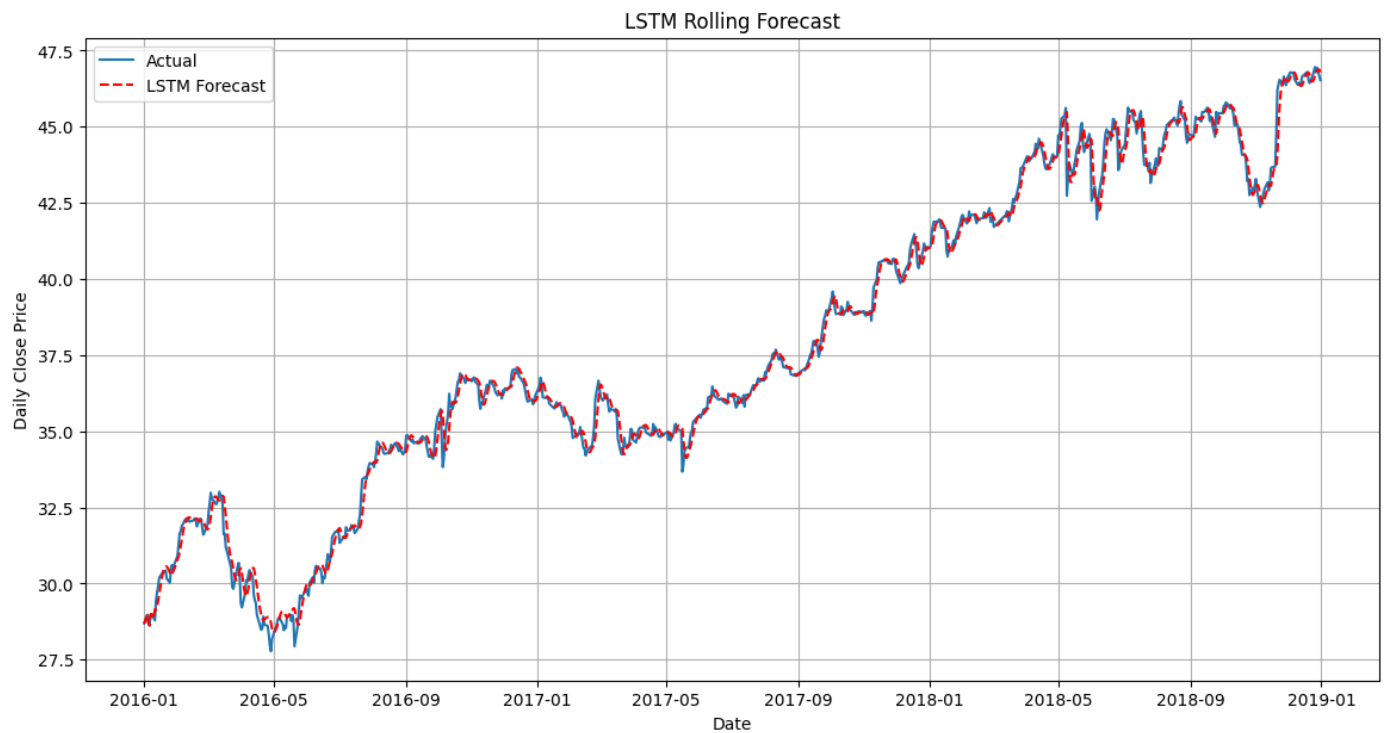
```
Processing agn...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0041 - val_loss: 3.4378
e-04
Epoch 2/20
144/144 [==============================] - 0s 3ms/step - loss: 2.6567e-05 - val_loss: 3.
9024e-04
Epoch 3/20
144/144 [==============================] - 1s 5ms/step - loss: 2.5848e-05 - val_loss: 3.
2579e-04
Epoch 4/20
144/144 [==============================] - 0s 3ms/step - loss: 2.5884e-05 - val_loss: 4.
2659e-04
Epoch 5/20
144/144 [==============================] - 0s 2ms/step - loss: 2.5831e-05 - val_loss: 4.
0001e-04
Epoch 6/20
144/144 [==============================] - 0s 3ms/step - loss: 2.4855e-05 - val_loss: 3.
1560e-04
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 2.7037e-05 - val_loss: 3.
0515e-04
Epoch 8/20
144/144 [==============================] - 0s 3ms/step - loss: 2.8803e-05 - val_loss: 3.
8694e-04
Epoch 9/20
144/144 [==============================] - 1s 4ms/step - loss: 2.4951e-05 - val_loss: 3.
4147e-04
Epoch 10/20
144/144 [==============================] - 1s 5ms/step - loss: 2.6690e-05 - val_loss: 4.
5270e-04
Epoch 11/20
144/144 [==============================] - 1s 5ms/step - loss: 2.3143e-05 - val_loss: 2.
7445e-04
Epoch 12/20
144/144 [==============================] - 1s 5ms/step - loss: 2.5666e-05 - val_loss: 2.
6866e-04
Epoch 13/20
144/144 [==============================] - 0s 3ms/step - loss: 2.1176e-05 - val_loss: 3.
2494e-04
Epoch 14/20
144/144 [==============================] - 0s 3ms/step - loss: 2.1566e-05 - val_loss: 3.
```

```
4356e-04
Epoch 15/20
144/144 [==============================] - 1s 4ms/step - loss: 2.4724e-05 - val_loss: 2.
6326e-04
Epoch 16/20
144/144 [==============================] - 1s 3ms/step - loss: 2.3326e-05 - val_loss: 2.
5987e-04
Epoch 17/20
144/144 [==============================] - 0s 3ms/step - loss: 1.9774e-05 - val_loss: 3.
1438e-04
Epoch 18/20
144/144 [==============================] - 0s 3ms/step - loss: 2.2764e-05 - val_loss: 3.
6430e-04
Epoch 19/20
144/144 [==============================] - 0s 3ms/step - loss: 2.6805e-05 - val_loss: 2.
8348e-04
Epoch 20/20
144/144 [==============================] - 0s 2ms/step - loss: 2.3149e-05 - val_loss: 3.
7378e-04
Model trained and saved.
```

```
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\agn\predictions.csv.
```


LSTM Rolling Forecast
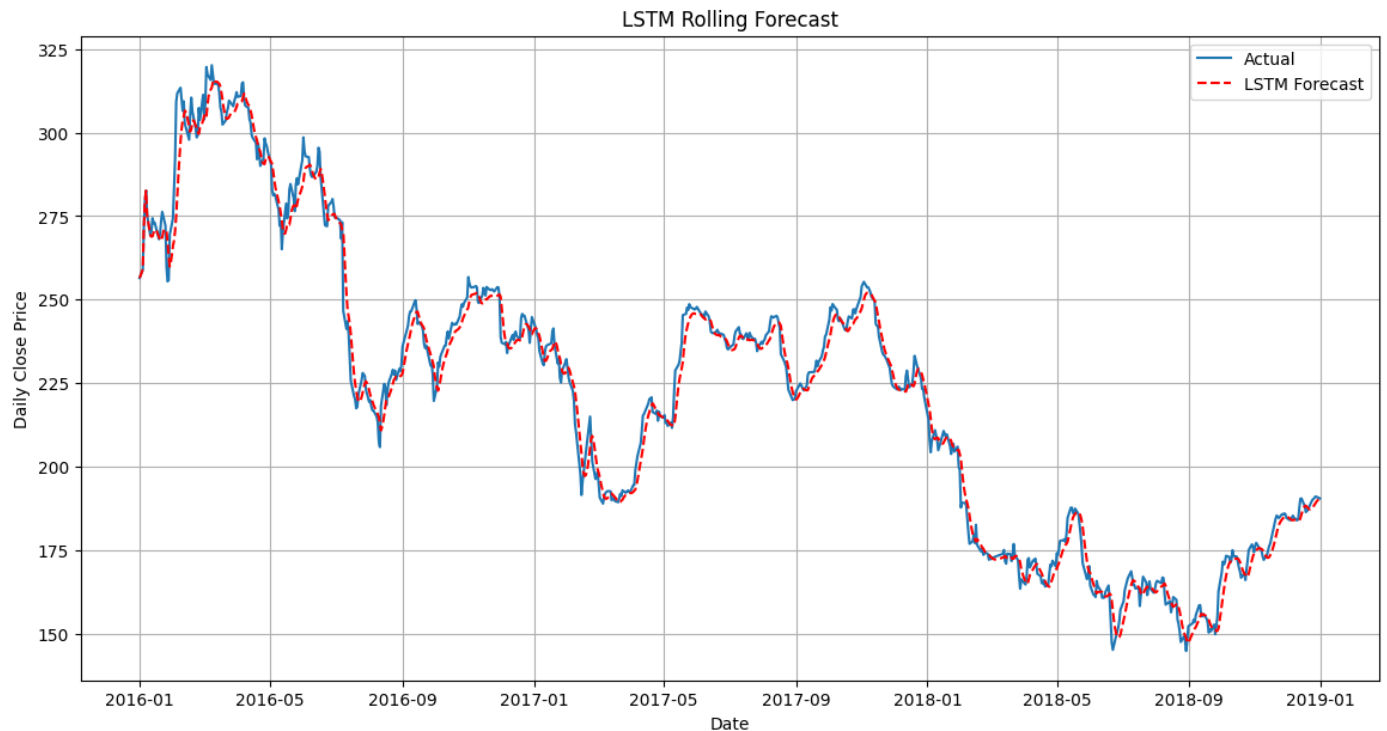
```
Processing aig...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0451 - val_loss: 3.1615
e-06
Epoch 2/20
144/144 [==============================] - 0s 3ms/step - loss: 3.1155e-04 - val_loss: 2.
5723e-06
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 2.4617e-04 - val_loss: 9.
9210e-07
Epoch 4/20
144/144 [==============================] - 0s 2ms/step - loss: 2.2894e-04 - val_loss: 3.
7196e-06
Epoch 5/20
```

```
144/144 [==============================] - 0s 2ms/step - loss: 2.1762e-04 - val_loss: 7.
3290e-07
Epoch 6/20
144/144 [==============================] - 1s 5ms/step - loss: 2.0895e-04 - val_loss: 6.
0200e-07
Epoch 7/20
144/144 [==============================] - 1s 4ms/step - loss: 2.0481e-04 - val_loss: 1.
3561e-05
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 2.0419e-04 - val_loss: 3.
4938e-06
Epoch 9/20
144/144 [==============================] - 1s 4ms/step - loss: 1.9700e-04 - val_loss: 6.
7019e-05
Epoch 10/20
144/144 [==============================] - 1s 4ms/step - loss: 1.9895e-04 - val_loss: 5.
4210e-05
Epoch 11/20
144/144 [==============================] - 1s 7ms/step - loss: 1.9620e-04 - val_loss: 1.
4817e-05
Epoch 12/20
144/144 [==============================] - 1s 4ms/step - loss: 1.8450e-04 - val_loss: 1.
5273e-05
Epoch 13/20
144/144 [==============================] - 0s 3ms/step - loss: 1.8347e-04 - val_loss: 1.
1540e-06
Epoch 14/20
144/144 [==============================] - 1s 6ms/step - loss: 1.8130e-04 - val_loss: 5.
2468e-06
Epoch 15/20
144/144 [==============================] - 1s 4ms/step - loss: 1.6759e-04 - val_loss: 4.
2948e-06
Epoch 16/20
144/144 [==============================] - 1s 4ms/step - loss: 1.6589e-04 - val_loss: 2.
0329e-05
Epoch 17/20
144/144 [==============================] - 1s 4ms/step - loss: 1.5033e-04 - val_loss: 1.
2973e-06
Epoch 18/20
144/144 [==============================] - 0s 3ms/step - loss: 1.4737e-04 - val_loss: 1.
0404e-05
Epoch 19/20
144/144 [==============================] - 0s 3ms/step - loss: 1.4081e-04 - val_loss: 5.
3192e-06
Epoch 20/20
144/144 [==============================] - 0s 3ms/step - loss: 1.3231e-04 - val_loss: 1.
7499e-05
Model trained and saved.
d:\ProgramFiles_Storage\anaconda3\Lib\site-packages\keras\src\engine\training.py:3103: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. This file form
at is considered legacy. We recommend using instead the native Keras format, e.g. `mode
l.save('my_model.keras')`.
  saving_api.save_model(
34/34 [==============================] - 0s 2ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\aig\predictions.csv.
```

LSTM Rolling Forecast
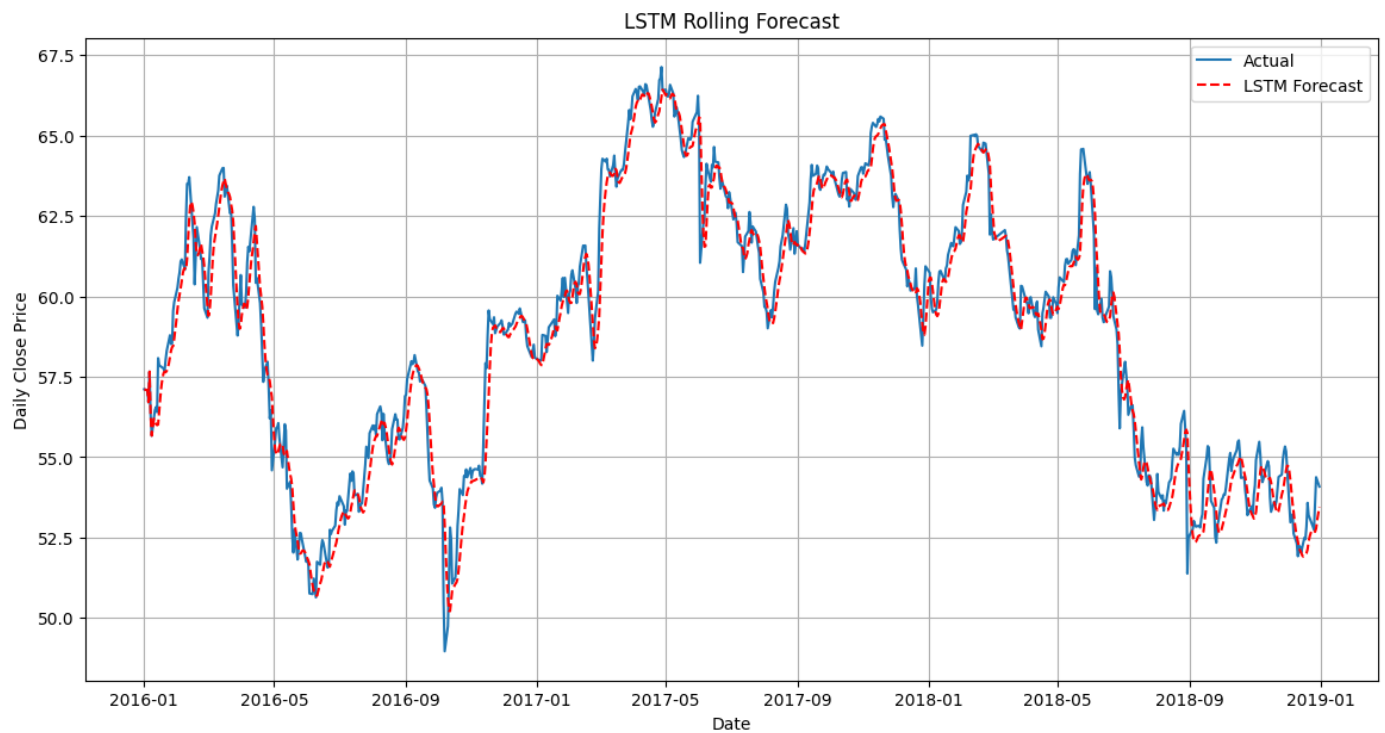
```
Processing aiv...
Epoch 1/20
144/144 [==============================] - 2s 6ms/step - loss: 0.0291 - val_loss: 1.5708
e-04
Epoch 2/20
144/144 [==============================] - 1s 4ms/step - loss: 2.6485e-04 - val_loss: 1.
4211e-04
Epoch 3/20
144/144 [==============================] - 0s 3ms/step - loss: 2.4381e-04 - val_loss: 1.
4141e-04
Epoch 4/20
144/144 [==============================] - 0s 2ms/step - loss: 2.3448e-04 - val_loss: 1.
3244e-04
Epoch 5/20
144/144 [==============================] - 0s 2ms/step - loss: 2.2419e-04 - val_loss: 2.
0538e-04
Epoch 6/20
144/144 [==============================] - 1s 4ms/step - loss: 2.1998e-04 - val_loss: 1.
0560e-04
Epoch 7/20
144/144 [==============================] - 0s 3ms/step - loss: 2.0902e-04 - val_loss: 2.
0359e-04
Epoch 8/20
144/144 [==============================] - 1s 4ms/step - loss: 1.9206e-04 - val_loss: 9.
9290e-05
Epoch 9/20
144/144 [==============================] - 1s 4ms/step - loss: 1.8589e-04 - val_loss: 2.
0174e-04
Epoch 10/20
144/144 [==============================] - 1s 5ms/step - loss: 1.7668e-04 - val_loss: 9.
3759e-05
Epoch 11/20
144/144 [==============================] - 0s 2ms/step - loss: 1.6716e-04 - val_loss: 1.
0837e-04
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 1.7554e-04 - val_loss: 9.
5556e-05
Epoch 13/20
144/144 [==============================] - 0s 3ms/step - loss: 1.5756e-04 - val_loss: 1.
5512e-04
Epoch 14/20
144/144 [==============================] - 0s 3ms/step - loss: 1.5795e-04 - val_loss: 9.
```

```
3059e-05
Epoch 15/20
144/144 [==============================] - 0s 3ms/step - loss: 1.4312e-04 - val_loss: 7.
3873e-05
Epoch 16/20
144/144 [==============================] - 0s 3ms/step - loss: 1.3666e-04 - val_loss: 6.
3404e-05
Epoch 17/20
144/144 [==============================] - 0s 3ms/step - loss: 1.2996e-04 - val_loss: 1.
0060e-04
Epoch 18/20
144/144 [==============================] - 0s 2ms/step - loss: 1.3402e-04 - val_loss: 1.
2624e-04
Epoch 19/20
144/144 [==============================] - 0s 2ms/step - loss: 1.2401e-04 - val_loss: 5.
9069e-05
Epoch 20/20
144/144 [==============================] - 0s 3ms/step - loss: 1.2534e-04 - val_loss: 6.
5089e-05
Model trained and saved.
```

```
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\aiv\predictions.csv.
```
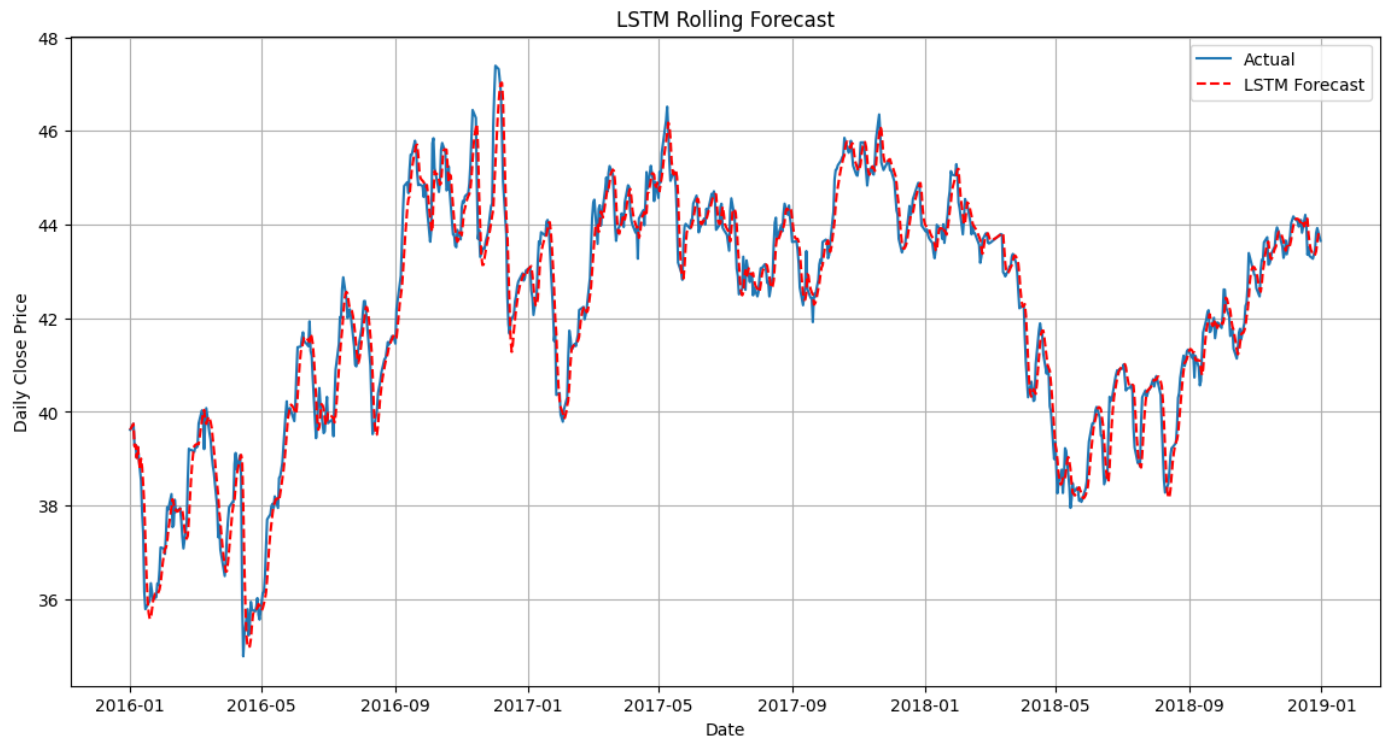


```
Processing amzn...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0090 - val_loss: 0.0018
Epoch 2/20
144/144 [==============================] - 0s 2ms/step - loss: 8.3868e-05 - val_loss: 0.
0011
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 7.6746e-05 - val_loss: 8.
5646e-04
Epoch 4/20
144/144 [==============================] - 0s 2ms/step - loss: 7.6931e-05 - val_loss: 6.
7315e-04
Epoch 5/20
```

```
144/144 [==============================] - 0s 2ms/step - loss: 7.4006e-05 - val_loss: 6.
2131e-04
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 7.7657e-05 - val_loss: 6.
8206e-04
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 7.2064e-05 - val_loss: 5.
5640e-04
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 7.2073e-05 - val_loss: 5.
2678e-04
Epoch 9/20
144/144 [==============================] - 0s 2ms/step - loss: 6.9357e-05 - val_loss: 4.
8325e-04
Epoch 10/20
144/144 [==============================] - 0s 3ms/step - loss: 6.8956e-05 - val_loss: 7.
4846e-04
Epoch 11/20
144/144 [==============================] - 0s 2ms/step - loss: 6.6389e-05 - val_loss: 4.
3574e-04
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 6.4313e-05 - val_loss: 4.
3597e-04
Epoch 13/20
144/144 [==============================] - 0s 2ms/step - loss: 6.2350e-05 - val_loss: 4.
2996e-04
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 6.2562e-05 - val_loss: 4.
4344e-04
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 6.6355e-05 - val_loss: 3.
5400e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 5.7358e-05 - val_loss: 3.
3351e-04
Epoch 17/20
144/144 [==============================] - 0s 2ms/step - loss: 5.8605e-05 - val_loss: 3.
3203e-04
Epoch 18/20
144/144 [==============================] - 0s 2ms/step - loss: 6.6962e-05 - val_loss: 3.
5708e-04
Epoch 19/20
144/144 [==============================] - 0s 2ms/step - loss: 5.5379e-05 - val_loss: 4.
2882e-04
Epoch 20/20
144/144 [==============================] - 0s 2ms/step - loss: 5.3726e-05 - val_loss: 3.
0202e-04
Model trained and saved.
d:\ProgramFiles_Storage\anaconda3\Lib\site-packages\keras\src\engine\training.py:3103: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. This file form
at is considered legacy. We recommend using instead the native Keras format, e.g. `mode
l.save('my_model.keras')`.
  saving_api.save_model(
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\amzn\predictions.csv.
```

LSTM Rolling Forecast
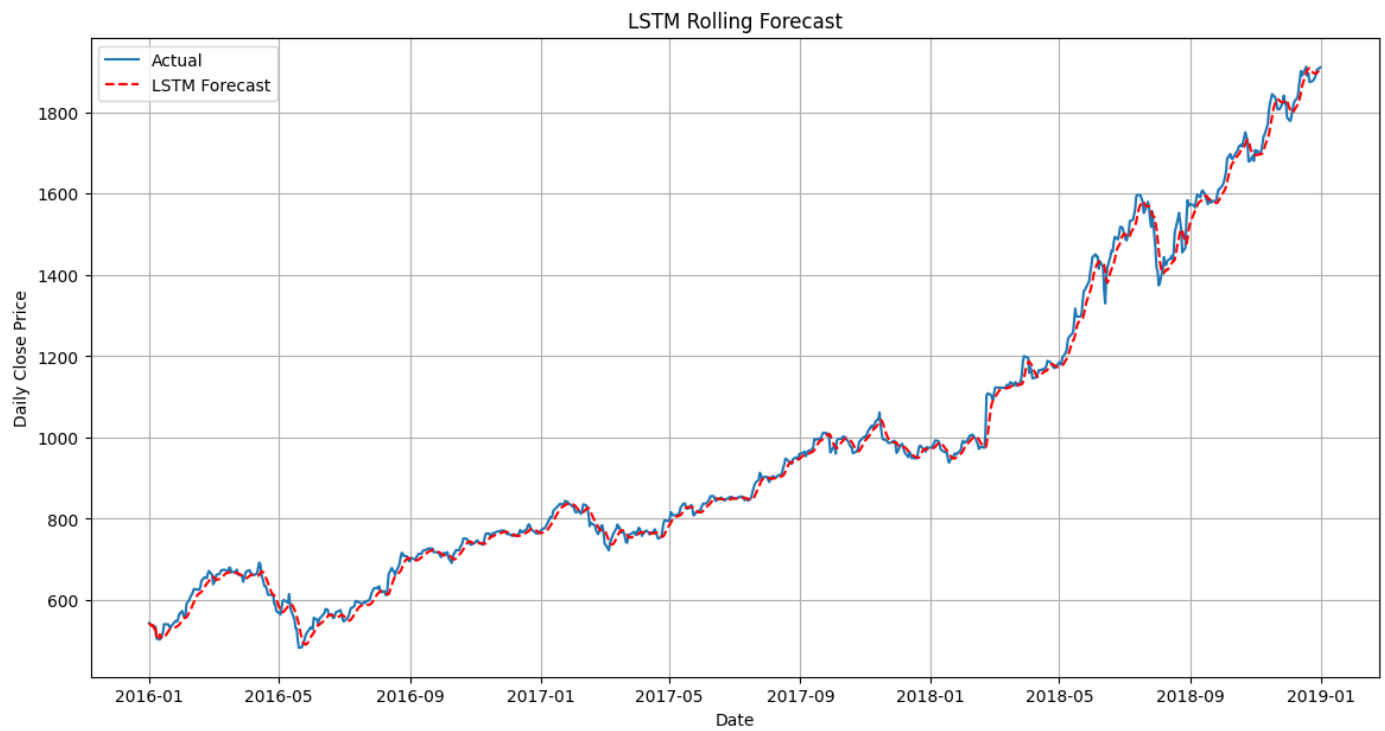
```
Processing jnj...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0204 - val_loss: 0.0028
Epoch 2/20
144/144 [==============================] - 0s 3ms/step - loss: 1.9185e-04 - val_loss: 0.
0018
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 1.6994e-04 - val_loss: 0.
0023
Epoch 4/20
144/144 [==============================] - 0s 3ms/step - loss: 1.6395e-04 - val_loss: 0.
0013
Epoch 5/20
144/144 [==============================] - 1s 4ms/step - loss: 1.4526e-04 - val_loss: 6.
9055e-04
Epoch 6/20
144/144 [==============================] - 0s 3ms/step - loss: 1.3468e-04 - val_loss: 6.
1424e-04
Epoch 7/20
144/144 [==============================] - 1s 6ms/step - loss: 1.2179e-04 - val_loss: 6.
2581e-04
Epoch 8/20
144/144 [==============================] - 0s 3ms/step - loss: 1.1201e-04 - val_loss: 3.
2861e-04
Epoch 9/20
144/144 [==============================] - 1s 4ms/step - loss: 1.1158e-04 - val_loss: 2.
0678e-04
Epoch 10/20
144/144 [==============================] - 1s 4ms/step - loss: 1.0157e-04 - val_loss: 2.
9527e-04
Epoch 11/20
144/144 [==============================] - 1s 3ms/step - loss: 9.7185e-05 - val_loss: 2.
3513e-04
Epoch 12/20
144/144 [==============================] - 0s 3ms/step - loss: 9.3252e-05 - val_loss: 1.
3688e-04
Epoch 13/20
144/144 [==============================] - 0s 3ms/step - loss: 9.1604e-05 - val_loss: 3.
6968e-04
Epoch 14/20
144/144 [==============================] - 0s 3ms/step - loss: 8.6840e-05 - val_loss: 1.
4493e-04
```

```
Epoch 15/20
144/144 [==============================] - 0s 3ms/step - loss: 8.8021e-05 - val_loss: 2.
0159e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 8.4640e-05 - val_loss: 1.
6531e-04
Epoch 17/20
144/144 [==============================] - 0s 3ms/step - loss: 7.8626e-05 - val_loss: 1.
2153e-04
Epoch 18/20
144/144 [==============================] - 0s 2ms/step - loss: 7.7168e-05 - val_loss: 1.
3215e-04
Epoch 19/20
144/144 [==============================] - 0s 2ms/step - loss: 7.3821e-05 - val_loss: 1.
1929e-04
Epoch 20/20
144/144 [==============================] - 0s 2ms/step - loss: 8.1640e-05 - val_loss: 1.
2011e-04
Model trained and saved.
```

```
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\jnj\predictions.csv.
```


LSTM Rolling Forecast
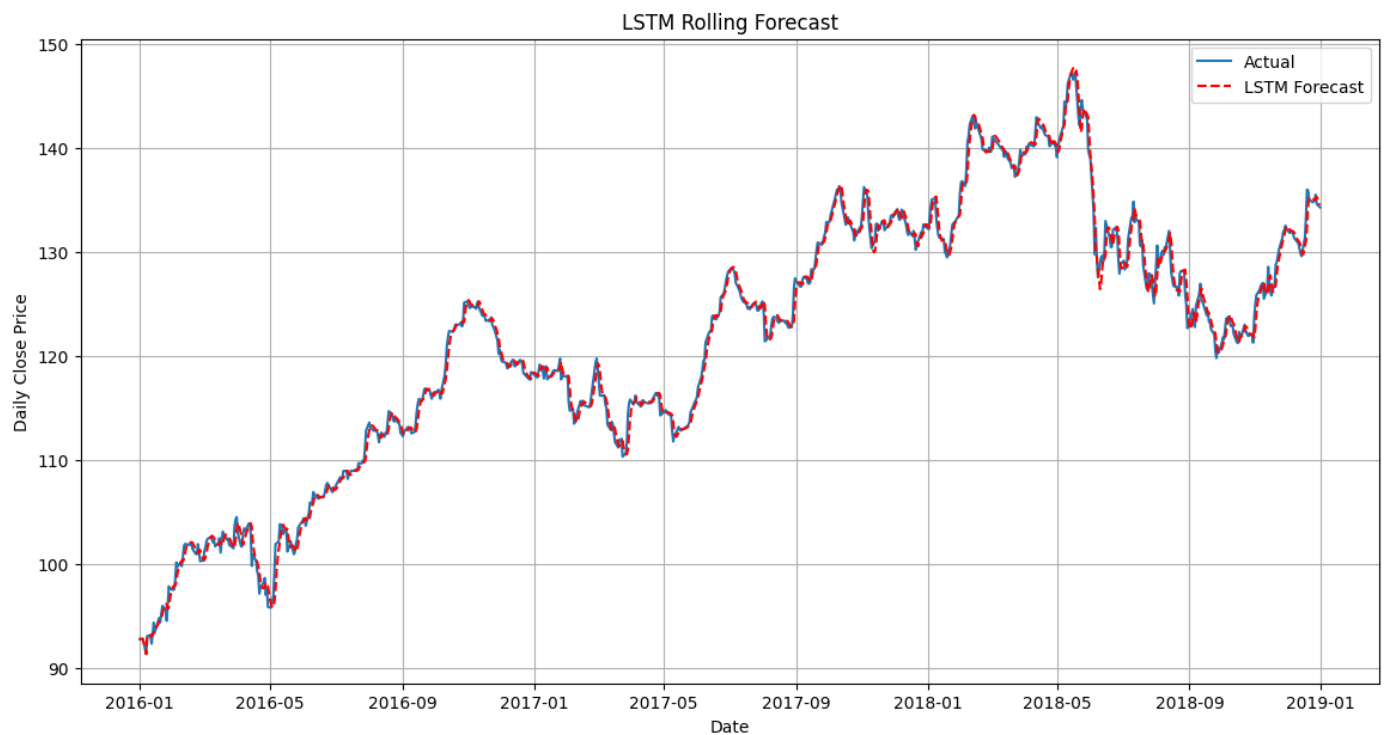
```
Processing jpm...
Epoch 1/20
144/144 [==============================] - 3s 4ms/step - loss: 0.0264 - val_loss: 0.0034
Epoch 2/20
144/144 [==============================] - 0s 3ms/step - loss: 5.9876e-04 - val_loss: 0.
0020
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 4.7316e-04 - val_loss: 7.
9821e-04
Epoch 4/20
144/144 [==============================] - 0s 2ms/step - loss: 4.2908e-04 - val_loss: 8.
7638e-04
Epoch 5/20
144/144 [==============================] - 0s 2ms/step - loss: 3.9452e-04 - val_loss: 5.
7534e-04
```

```
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 3.3550e-04 - val_loss: 2.
9676e-04
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 3.0737e-04 - val_loss: 5.
9373e-04
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 2.6064e-04 - val_loss: 2.
4320e-04
Epoch 9/20
144/144 [==============================] - 0s 2ms/step - loss: 2.5551e-04 - val_loss: 3.
6921e-04
Epoch 10/20
144/144 [==============================] - 0s 3ms/step - loss: 2.3896e-04 - val_loss: 3.
3476e-04
Epoch 11/20
144/144 [==============================] - 0s 2ms/step - loss: 2.2025e-04 - val_loss: 3.
1045e-04
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 2.0719e-04 - val_loss: 1.
8315e-04
Epoch 13/20
144/144 [==============================] - 0s 2ms/step - loss: 2.1069e-04 - val_loss: 1.
5520e-04
Epoch 14/20
144/144 [==============================] - 0s 3ms/step - loss: 1.9222e-04 - val_loss: 1.
2925e-04
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8595e-04 - val_loss: 1.
4153e-04
Epoch 16/20
144/144 [==============================] - 0s 3ms/step - loss: 1.8765e-04 - val_loss: 2.
4915e-04
Epoch 17/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8342e-04 - val_loss: 1.
6497e-04
Epoch 18/20
144/144 [==============================] - 0s 2ms/step - loss: 1.7606e-04 - val_loss: 1.
3614e-04
Epoch 19/20
144/144 [==============================] - 0s 2ms/step - loss: 1.7301e-04 - val_loss: 1.
3397e-04
Epoch 20/20
144/144 [==============================] - 0s 2ms/step - loss: 1.6125e-04 - val_loss: 1.
7631e-04
Model trained and saved.
 1/34 [..............................] - ETA: 4s
d:\ProgramFiles_Storage\anaconda3\Lib\site-packages\keras\src\engine\training.py:3103: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. This file form
at is considered legacy. We recommend using instead the native Keras format, e.g. `mode
l.save('my_model.keras')`.
  saving_api.save_model(
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\jpm\predictions.csv.
```
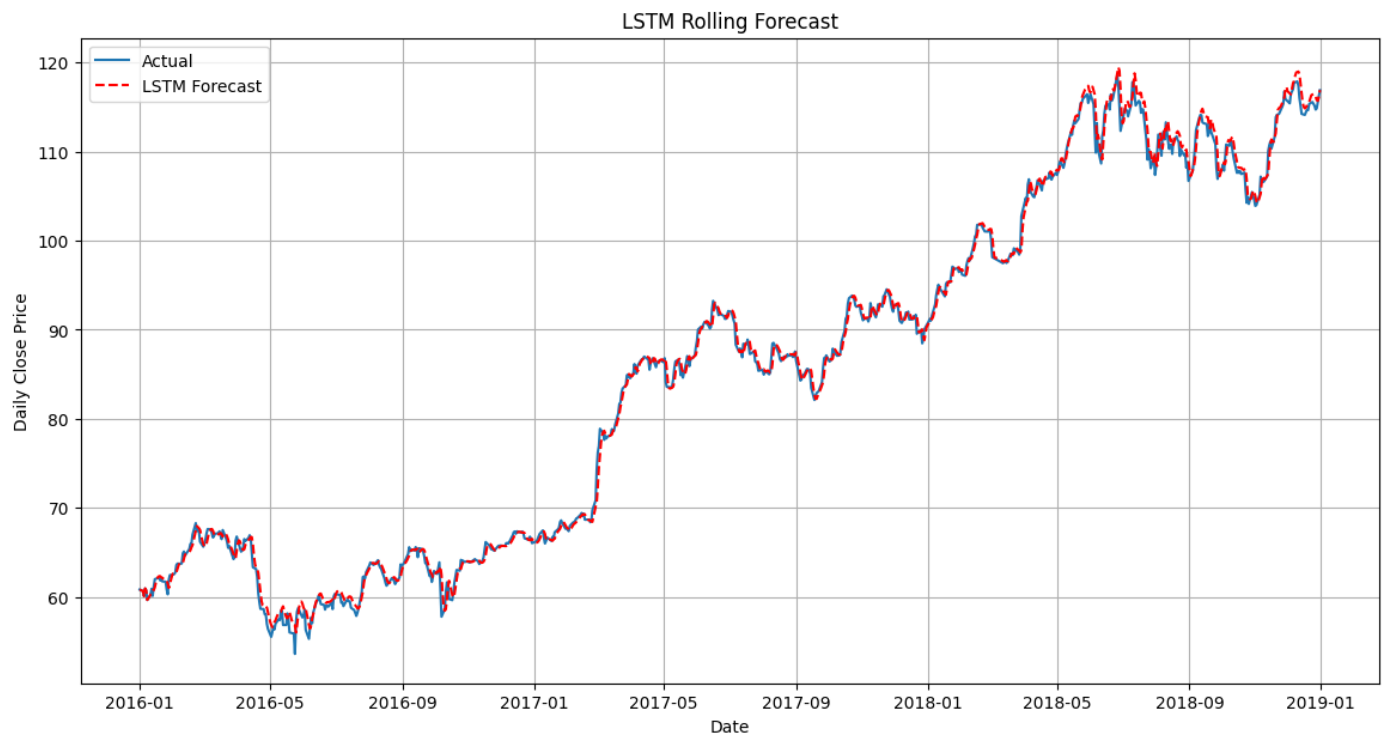
LSTM Rolling Forecast

```
Processing ko...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0095 - val_loss: 0.0015
Epoch 2/20
144/144 [==============================] - 0s 2ms/step - loss: 2.8148e-04 - val_loss: 9.
3187e-04
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 2.5535e-04 - val_loss: 7.
3446e-04
Epoch 4/20
144/144 [==============================] - 0s 2ms/step - loss: 2.4345e-04 - val_loss: 5.
4771e-04
Epoch 5/20
144/144 [==============================] - 0s 2ms/step - loss: 2.4981e-04 - val_loss: 5.
2561e-04
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 2.3745e-04 - val_loss: 5.
2385e-04
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 2.2760e-04 - val_loss: 4.
0172e-04
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 2.2530e-04 - val_loss: 3.
6748e-04
Epoch 9/20
144/144 [==============================] - 0s 2ms/step - loss: 2.0370e-04 - val_loss: 4.
5822e-04
Epoch 10/20
144/144 [==============================] - 0s 2ms/step - loss: 2.0145e-04 - val_loss: 3.
4111e-04
Epoch 11/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8972e-04 - val_loss: 3.
0681e-04
Epoch 12/20
144/144 [==============================] - 0s 3ms/step - loss: 1.8175e-04 - val_loss: 3.
5173e-04
Epoch 13/20
144/144 [==============================] - 0s 3ms/step - loss: 1.7816e-04 - val_loss: 3.
5946e-04
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 1.6385e-04 - val_loss: 2.
3042e-04
```

```
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 1.6240e-04 - val_loss: 2.
4174e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 1.5348e-04 - val_loss: 1.
9656e-04
Epoch 17/20
144/144 [==============================] - 0s 2ms/step - loss: 1.4232e-04 - val_loss: 1.
8392e-04
Epoch 18/20
144/144 [==============================] - 0s 2ms/step - loss: 1.3999e-04 - val_loss: 1.
7521e-04
Epoch 19/20
144/144 [==============================] - 0s 2ms/step - loss: 1.3791e-04 - val_loss: 1.
7214e-04
Epoch 20/20
144/144 [==============================] - 0s 2ms/step - loss: 1.3216e-04 - val_loss: 2.
1608e-04
Model trained and saved.
 1/34 [..............................] - ETA: 4s
```
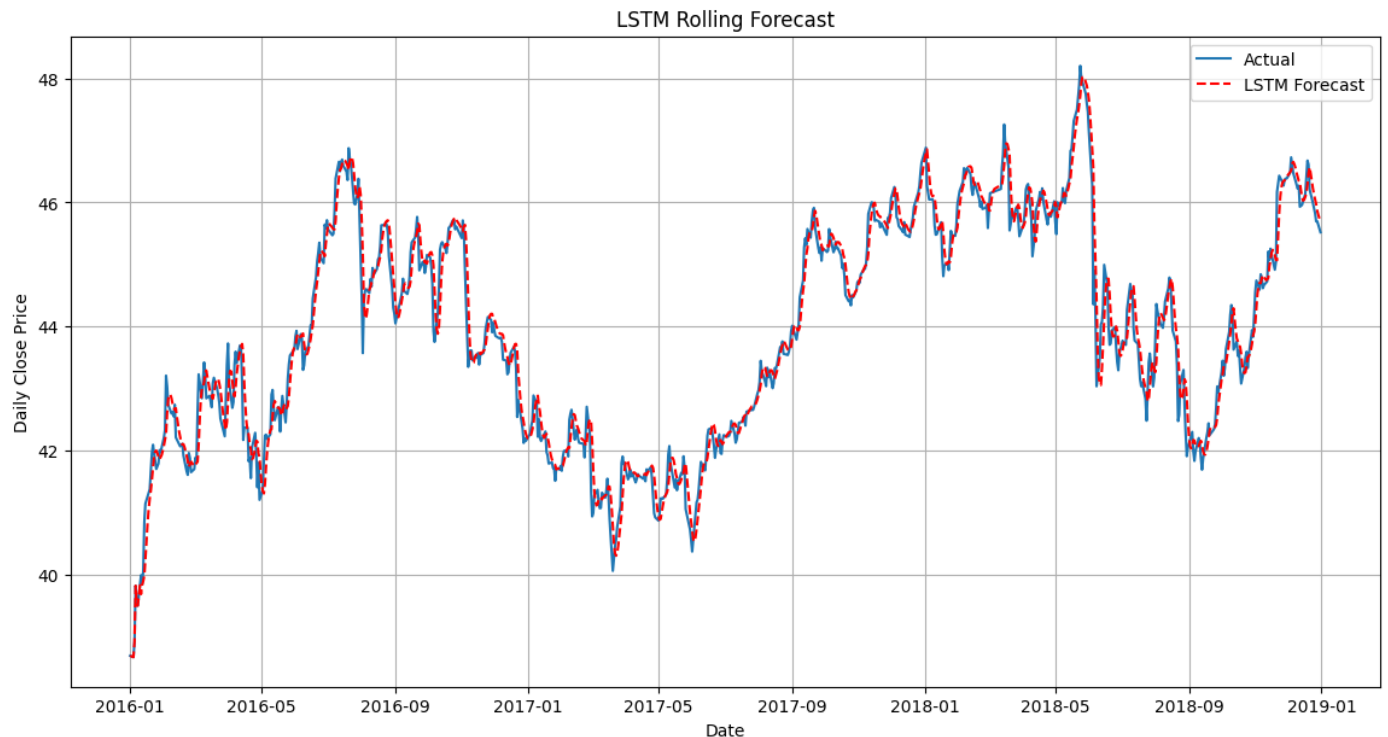
d:\ProgramFiles_Storage\anaconda3\Lib\site-packages\keras\src\engine\training.py:3103: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. This file form
at is considered legacy. We recommend using instead the native Keras format, e.g. `mode
l.save('my_model.keras')`.
  saving_api.save_model(

```
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\ko\predictions.csv.
```


LSTM Rolling Forecast

```
Processing mmm...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0080 - val_loss: 0.0039
Epoch 2/20
144/144 [==============================] - 0s 2ms/step - loss: 1.2896e-04 - val_loss: 0.
0028
Epoch 3/20
144/144 [==============================] - 0s 2ms/step - loss: 1.2274e-04 - val_loss: 0.
0022
Epoch 4/20
144/144 [==============================] - 0s 2ms/step - loss: 1.1897e-04 - val_loss: 0.
0017
Epoch 5/20
```

```
144/144 [==============================] - 0s 2ms/step - loss: 1.1578e-04 - val_loss: 0.
0014
Epoch 6/20
144/144 [==============================] - 0s 3ms/step - loss: 1.1148e-04 - val_loss: 5.
5099e-04
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 1.1446e-04 - val_loss: 7.
5905e-04
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 1.0389e-04 - val_loss: 0.
0014
Epoch 9/20
144/144 [==============================] - 0s 2ms/step - loss: 1.0440e-04 - val_loss: 2.
5553e-04
Epoch 10/20
144/144 [==============================] - 0s 3ms/step - loss: 9.4332e-05 - val_loss: 8.
2986e-04
Epoch 11/20
144/144 [==============================] - 0s 2ms/step - loss: 9.6508e-05 - val_loss: 3.
9028e-04
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 9.0854e-05 - val_loss: 0.
0011
Epoch 13/20
144/144 [==============================] - 0s 2ms/step - loss: 8.6212e-05 - val_loss: 5.
2648e-04
Epoch 14/20
144/144 [==============================] - 0s 2ms/step - loss: 8.5584e-05 - val_loss: 4.
6773e-04
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 7.7211e-05 - val_loss: 1.
5833e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 7.5376e-05 - val_loss: 2.
3317e-04
Epoch 17/20
144/144 [==============================] - 0s 2ms/step - loss: 7.3312e-05 - val_loss: 2.
9026e-04
Epoch 18/20
144/144 [==============================] - 0s 2ms/step - loss: 6.9115e-05 - val_loss: 1.
0943e-04
Epoch 19/20
144/144 [==============================] - 0s 2ms/step - loss: 7.2654e-05 - val_loss: 9.
9258e-05
Epoch 20/20
144/144 [==============================] - 0s 3ms/step - loss: 7.0417e-05 - val_loss: 2.
5071e-04
Model trained and saved.
 1/34 [..............................] - ETA: 4s
d:\ProgramFiles_Storage\anaconda3\Lib\site-packages\keras\src\engine\training.py:3103: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. This file form
at is considered legacy. We recommend using instead the native Keras format, e.g. `mode
l.save('my_model.keras')`.
  saving_api.save_model(
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\mmm\predictions.csv.
```
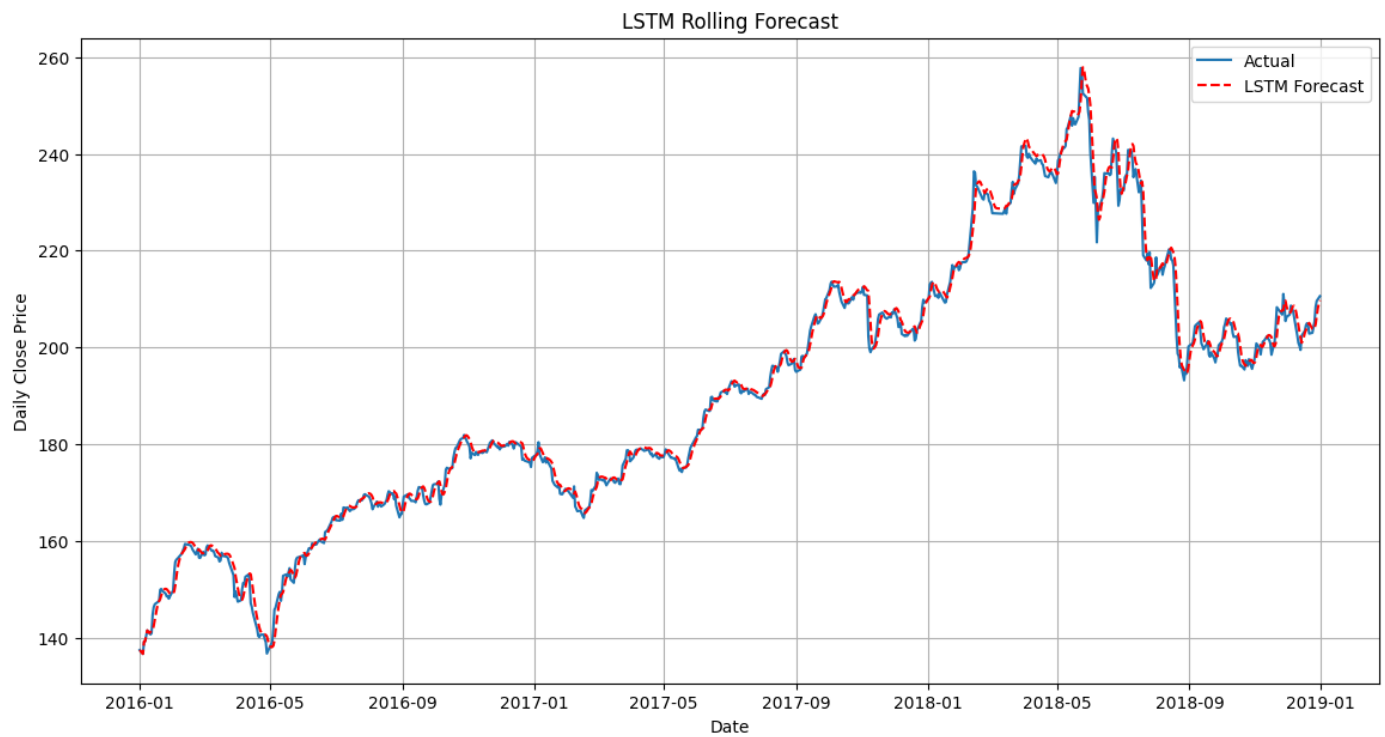
LSTM Rolling Forecast

```
Processing msft...
Epoch 1/20
144/144 [==============================] - 2s 4ms/step - loss: 0.0105 - val_loss: 0.0082
Epoch 2/20
144/144 [==============================] - 0s 2ms/step - loss: 3.1361e-04 - val_loss: 0.
0020
Epoch 3/20
144/144 [==============================] - 0s 3ms/step - loss: 2.7967e-04 - val_loss: 0.
0025
Epoch 4/20
144/144 [==============================] - 0s 2ms/step - loss: 2.6189e-04 - val_loss: 0.
0022
Epoch 5/20
144/144 [==============================] - 0s 2ms/step - loss: 2.4624e-04 - val_loss: 0.
0020
Epoch 6/20
144/144 [==============================] - 0s 2ms/step - loss: 2.3789e-04 - val_loss: 0.
0015
Epoch 7/20
144/144 [==============================] - 0s 2ms/step - loss: 2.2248e-04 - val_loss: 8.
4450e-04
Epoch 8/20
144/144 [==============================] - 0s 2ms/step - loss: 2.1108e-04 - val_loss: 0.
0017
Epoch 9/20
144/144 [==============================] - 0s 2ms/step - loss: 1.9921e-04 - val_loss: 6.
2843e-04
Epoch 10/20
144/144 [==============================] - 0s 3ms/step - loss: 1.8863e-04 - val_loss: 8.
4122e-04
Epoch 11/20
144/144 [==============================] - 0s 2ms/step - loss: 1.8908e-04 - val_loss: 7.
1677e-04
Epoch 12/20
144/144 [==============================] - 0s 2ms/step - loss: 1.6605e-04 - val_loss: 8.
0257e-04
Epoch 13/20
144/144 [==============================] - 0s 2ms/step - loss: 1.5882e-04 - val_loss: 3.
6769e-04
Epoch 14/20
144/144 [==============================] - 0s 3ms/step - loss: 1.5201e-04 - val_loss: 3.
7004e-04
```

```
Epoch 15/20
144/144 [==============================] - 0s 2ms/step - loss: 1.4779e-04 - val_loss: 3.
2774e-04
Epoch 16/20
144/144 [==============================] - 0s 2ms/step - loss: 1.4927e-04 - val_loss: 3.
5137e-04
Epoch 17/20
144/144 [==============================] - 0s 3ms/step - loss: 1.4980e-04 - val_loss: 5.
5259e-04
Epoch 18/20
144/144 [==============================] - 0s 2ms/step - loss: 1.3766e-04 - val_loss: 2.
7249e-04
Epoch 19/20
144/144 [==============================] - 0s 3ms/step - loss: 1.3479e-04 - val_loss: 2.
6298e-04
Epoch 20/20
144/144 [==============================] - 0s 2ms/step - loss: 1.2689e-04 - val_loss: 3.
2364e-04
Model trained and saved.
```

d:\ProgramFiles_Storage\anaconda3\Lib\site-packages\keras\src\engine\training.py:3103: U
serWarning: You are saving your model as an HDF5 file via `model.save()`. This file form
at is considered legacy. We recommend using instead the native Keras format, e.g. `mode
l.save('my_model.keras')`.
  saving_api.save_model(

```
34/34 [==============================] - 0s 1ms/step
Predictions saved to d:\Personal_Folders\Tocho\UMD\spring_2024\CMSC421\cmsc421_final_pro
ject\agents\trained_models\msft\predictions.csv.
```